THE JOURNAL OF ENGINEERING EDUCATION

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Contents for February, 1945

APPLICATION FOR MEMBERSHIP

Date ______________________

The undersigned, desiring to become a member of the Society for the Promotion of Engineering Education, hereby agrees to conform to the requirements of membership, if elected, and submits the following statement of qualifications:

Name ____
Print last name First Middle

Mailing address ______________________________________

City and State _______________________________________

Full title of
professional position ____________________ ____________________
Title Department

Institution ____

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To be signed by two sponsors and returned to F. L. Bishop, Secretary, S. P. E. E.,
University of Pittsburgh, Pittsburgh, Pa.

A 1945 Text

A new approach for the Course in Personnel Administration—Industrial Relations

Personnel Relations

By **J. E. Walters,** *Principal, McKinsey & Company; formerly Professor of Personnel Administration, Purdue University*

A forward-looking text that views personnel relations as the mutual and reciprocal interest which persons and groups of persons have in each other—in this case employees, employers, and the public. It presents management's point-of-view, when the management of personnel relations is being considered; government's, when governmental regulations and cooperation are discussed; labor's, when the aims and action of labor unions are viewed.

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Scope of Contents

I. Workers as Determinants of Personnel Relations. Labor Unions in a Democracy.

II. Management of Personnel Relations. Wages.

III. Personnel Relations Techniques. Employment. Job Evaluation. Ratings. Labor Turnover, Promotion, Transfers. Records. Statistics. Training. Health Activities. Morale Surveys. Safety. Employee Service. Women in Industry. The Individual in Democratic Personnel Relations.

IV. Governmental Cooperation with and Regulation of Personnel Relations. The National Personnel Relations Policy. Minimum Wages and Maximum Hours. Social Security. Governmental Agencies Cooperating.

V. Union-Management-Government Cooperation.

The Ronald Press Company ***Publishers***

15 East 26th Street **New York 10**

Secretary—J. B. Johnson, Washington University,
Treasurer—Storm Bull, University of Wisconsin.

There were twenty-one members of the Council, divided into three groups, whose terms of office expired in 1894, 1895 and 1896.

PURPOSE

There is no mention made in Volume One of Proceedings of the purposes that actuated the founding of the Society. However, at the end of its first year of life, Volume II was published to record the proceedings of what is sometimes referred to as its first annual meeting, which was held at The Polytechnic Institute of Brooklyn, for three days in August of 1894. In this we find the following quotations that appear under the title "Objects and Opportunities of the Society for the Promotion of Engineering Education"

"The Society was organized at the close of the Engineering Congress held in Chicago in August, 1893. It grew out of a common feeling of the seventy or more members of Section E of that Congress on Engineering Education that a permanent organization should be established of those engineers and teachers most interested, which should meet annually for conference and discussion."

Further it is said:

"The Engineering Schools of America are still in a formative stage, with a prospect that many of them will become, at a very early date, very nearly the ideal Engineering Schools.

"The shaping of the technical education of a nation is a work which may well call for the continuous service of our ablest educators, and the advantages of participating in the work should accrue to each and every school, college, or university in the country, which undertakes to impart technical instruction, through its professors and teachers who are members of the Society which is principally charged with this work."

and it then continues, prophetically:

"There is now little question that this Society will have a great and lasting influence in shaping the development of our Engineering Schools, and while the teachers of our leading technical schools have, to date, shown the greatest interest in this work, the greatest advantages are likely to be reaped by those members who represent the newer and smaller schools, the principal development of which is in the future."

A further statement of purposes is found in the introduction to Volume IV of the Proceedings:

"The spirit which pervades engineering colleges can properly be expected to secure superior results, not merely by virtue of the subjects taught, but also by improving the quality of teaching, perfecting the methods of presentation, and adapting means to ends in instruction, as has been done in engineering. It is the purpose of the Society to aid in bringing about this research. The work of teaching engineering subjects is sufficiently new, so that much saving will result in teaching, as in engineering, if the experience on the part of one shall prevent needless experimenting on the part of many."

In fulfillment of these objectives the Society assumed a position of influence from its earliest years.

At the end of its first year Volume II of the Proceedings, which records the activities of the Brooklyn meeting, lists 156 members, of whom 70 are designated as having become members in 1893, and 86 in 1894. These 70 members of 1893 include practically all of those who registered in attendance at the meetings of Section E of the

World's Engineering Conference. It is interesting to note that until 1909 the annual Volume of Proceedings, except Volume I, listed the names of all members. For many years all deceased members were listed. The current membership is 3787 individual and 160 institutional.

Meetings

In the original Constitution of 1893, we find this section on Meetings:

"There shall be a regular annual meeting occurring at the time and place of the meetings of the American Association for the Advancement of Science."

In 1894, this was added:

"or of some one of the National Engineering Societies, or otherwise as the Council may determine."

Undoubtedly the actuating motive for this provision was the convenience and the savings in traveling expenses of its members. A secondary reason may have been, however, the belief that the membership and the attendance at the annual meetings of the Society would thus be larger.

There was some sentiment in favor of scheduling the annual meeting in conjunction with the meetings of the Founder Engineering Societies and a few meetings were thus scheduled. In the beginning, most of the annual meetings of the Society just preceded or just followed the meetings of the American Association for the Advancement of Science.

Committees

Throughout the years, many of the achievements of the Society have been due to the work of its committees and it is interesting to note that the first committee,—on "Entrance Requirements for Engineering Colleges," was established at the Brooklyn Meeting of 1894. Another,—on "Uniformity of Symbols for Engineering Text-Books," was created at the Springfield, Massachusetts meeting the following year.

Additional committees have, of course, been appointed, have performed their useful work and have reported their findings and recommendations to the membership, partly by bulletins, but mainly through papers presented at the annual meetings and printed in the annual Proceedings.

Journal

In 1910 a Bulletin was established and became one of the principal milestones of the Society. In 1925, the name was changed to The Journal of Engineering Education.

Through the Journal our members are able to keep in touch with new thoughts and new developments in engineering education and its allied activities. Many of the papers presented at the annual meeting reach every member sometime before the publication of the bound volume of Proceedings for the year. The Journal has been a major implement in the ever-growing value and influence of the Society.

Institutional Membership

Other major developments followed in rapid sequence. Institutional membership was created at the Minneapolis Meeting of 1913, and, after a somewhat slow start, the first Institutional Representatives held their organization meetings at the Iowa State College Meeting, on June 22, 1915. Their principal early function was to become well acquainted with the work and aims of the Society and to carry this

information to the members of their respective faculties.

The Mann Report

The first of the major investigations with which the Society has been connected was "A Study of Engineering Education," by Professor Charles Riborg Mann. Its results were published in 1918 by The Carnegie Foundation for the Advancement of Teaching, as their Bulletin Number Eleven. It is generally referred to as the Mann Report.

The original impulse behind the making of this study was given by the Society for the Promotion of Engineering Education. "At its Cleveland Meeting, in 1907, the Society invited the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Chemical Society to join with it in appointing delegates to a 'Joint Committee on Engineering Education,' to examine into all branches of engineering education, including engineering research, graduate professional courses, undergraduate engineering instruction, and the proper relations of engineering schools to secondary industrial schools, or foremen's schools, and to formulate a report or reports upon the appropriate scope of engineering education and the degree of cooperation and unity that may be advantageously arranged between the various engineering schools."

At the Detroit Meeting, in 1908, it was decided to invite the Carnegie Foundation for the Advancement of Teaching and the General Education Board to appoint delegates to the Committee. The American Society of Civil Engineers appropriated a sum of money to further the investigation, and a considerable amount of material was gathered. However, it became evident that a much larger fund would be needed. This was generously provided by the Carnegie Foundation, and Professor Mann was finally selected to make a careful investigation and report. The Committee was augmented by delegates from the American Institute of Chemical Engineers and the American Institute of Mining Engineers.

The purpose of the study, as stated by Henry S. Pritchett, President of the Carnegie Foundation was:

> "Not so much to record the details of engineering teaching in the various schools as to examine the fundamental question of the right methods of teaching and the preparation of young men for the engineering professions: in other words, to question anew the pedagogic solution of fifty years ago, to examine the curriculum of today and the methods of teaching now employed, and to suggest in the light of fifty years of experience the pedagogic basis of the course of study intended to prepare young men for the work demanded of the engineer of today. In the effort to do this, the point of view of the teacher, of the engineer, and of the manufacturer and employer has been kept

After the Carnegie Foundation assumed the expenses connected with this study, it cared for all the administrative details. Dr. Mann had full responsibility. The Joint Committee on Engineering Education of the national engineering societies stated, in the Introduction to the report that: "They have been closely associated with Professor Mann during his investigations, and have frequently conferred with him in the program of the work and in the different plans adopted for securing information."

The following quotations from the Introduction by the Joint Committee are illuminating:

"We believe that this report possesses particular significance on account of the simple and clear treatment of the complicated problems involved. The history of the origin and development of the schools is concisely told, and the connection between the curriculum and the changing demands of industrial activities and growth is clearly narrated. If the study went no farther—and this is but the threshold of the report—we believe the value of this result alone would go far toward repaying the expense of the enquiry, liberal as that has been.

"Other significant characteristics of the report are found in the discussions of the general failure to recognize such factors as 'values and cost,' the importance of teaching technical subjects so as to develop character, the necessity for laboratory and industrial training throughout the courses, and the use of good English."

In commenting, concerning the great emphasis which the Report placed upon the teaching of the fundamental sciences, the Committee says:

"Emphasis is also given to the necessity for a broader training in the fundamentals of science as an equipment for all engineers and forming a sort of 'common core' in every curriculum. With this broad training in the first and second years, the student is expected to develop some natural leaning toward a specialty, and then will follow vocational guidance in the later stages of his education."

This Mann Report has been and continues to be widely and frequently quoted. Possibly the most frequently quoted sections are those referring to the personal characteristics of engineering college graduates most sought by the employers. Of that portion of the Report the Committee says, in the Introduction:

"It may take time to convince all that a measure, or scale, has been created by the practising engineers of the country by which an estimate may be formed of the amount of success in engineering teaching, irrespective of the special courses involved. That scale is the improvement of character, resourcefulness, judgment, efficiency, understanding of men, and, last of all, technique, as shown by students. These facts have already been published and widely circulated, and since they became known there are probably few intelligent educators who have not asked themselves the question—Am I so teaching as to produce these results in my pupils, and in the order of value specified by the Engineering profession?"

Sections and Branches

In 1918, at the Baltimore Meeting, Sections of the Society were authorized. The first section to be organized was the Pittsburgh Section, October 1918. This Section later became the Allegheny Section.

Today, through 18 of these Sections of the Society, covering the whole of the country, holding regional meetings of their own, the activities of the Society have been multiplied many times. Interest and membership have been greatly increased. Many educators, industrialists and others interested in engineering education, who are unable for one reason or another to attend the annual meetings, have opportunity to meet once or twice each year with others who are engaged in their own geographical sections. Formal and informal views are exchanged. Without doubt, the added understanding and interest in the activities of the Society that result from these sectional meetings have been among the major impulses that have brought about the greatly increased attendance at the annual meetings of these later years.

It was not long after the Sections had been successfully launched that the Branches of the Society got under way. They were first started during the academic year of 1921–1922. Then, at the Illinois Meeting of 1922, additional By-Laws were adopted covering both Branches and Divisions. The Branches now serve individual institutions and the Sections serve geographical areas.

Up to 1921 the annual meetings of the Society consisted of general sessions which were attended by all members.

Time, however, brought continued infusion of science into engineering curricula, and it brought also continued expansion of its applications. As these curricula "specialties" grew in number and importance, teachers wished to hold smaller group meetings at which more detailed consideration of their own fields could be given. These growing interests forced the development of the Divisions of the Society as we know them today. They were authorized by By-Laws adopted at the Illinois meeting, in 1922.

Divisions

The first one established was the Division of Deans and Administrative Officers. It was authorized at the 1922 meeting, following a preliminary organization at the Yale Meeting, of 1921. The activities of that first Division waxed and waned until they were given new impetus by re-establishment at the Chicago Meeting of the Council, on October 26, 1942. Since then it has been, and now is, very active with such college administrative problems as Selective Service, organization and development of Engineering, Science and Management War Training Courses, War Man Power Training, distribution of Surplus War Property, and Research problems.

Next in chronology, came what many feel, as voiced by Dean Potter, was "the greatest and most beneficial impetus to engineering education which it has received throughout its entire history," the studies and report of the Board of Investigation and Coordination.

The Wickenden Report

The stimulus for this undertaking came first through a number of editorials in The Journal of Engineering Education. Following these came the presidential address of Professor Charles F. Scott at the annual meeting of the Society at Urbana in 1922. These stimulated the appointment of a Development Committee to formulate an answer to the question "What can the Society do in a comprehensive way to develop, broaden and enrich engineering education?" This committee, in August 1922, recommended the appointment of a Board of Investigation and Coordination, which was appointed and began its duties in October 1922.

To continue from the Report of Professor Charles F. Scott, Chairman of Board:

> "The Committee recommended that the Society undertake a comprehensive survey directed by a Board, which should have authority to appoint a Director of Investigation and a staff, and to secure funds for carrying out a comprehensive program. Later the members of the Committee were appointed members of the Board of Investigation and Coordination. The report of the Development Committee was then sent to the heads of Engineering Schools and received constructive comment. A year later funds were secured and a Director appointed."

The Board fortunately secured the very able services of W. E. Wickenden as Director of Investigations, and H. P. Hammond as Associate Director.

During the period of formulating plans and policies, many organizations and individuals were consulted. Among these the President of the General Education Board "Suggested that a study of education in European Countries might be helpful in engineering, as it had been in other fields; a suggestion which resulted in a most fruitful part of our project."

The "Mann Report" had indicated that a further investigation was desirable. When this proposed project was presented to Dr. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching who, at this time was acting as President of the Carnegie Corporation, he, therefore, received it cordially. Conferences with Dr. Pritchett "resulted in an outline for the proposed study, which he approved in a letter, May 29, 1923, which concluded with these words, 'and I shall heartily recommend that the Carnegie Corporation participate in its support.' Favorable action was taken in October of that year, and a grant of funds was made covering the first three years of the proposed five-year program."

Toward the end of the initial three-year period twenty-six additional foundations, engineering societies, business corporations and individuals provided the funds to complete the study and publish its findings. The project was carried on over a period of ten years. The main report, 1039 pages, covers the studies made between 1923–1929; the Second Volume of the Report, issued in 1934, completes the project. The two volumes contain 1320 pages of the main report and 283 pages reporting, "A Study of Technical Institutes, a Collateral Project of The Investigation of Engineering Education."

So great were Professor Scott contributions to this study as Chairman of the Board of Investigation and Coordination that he was continued in office as President of the Society for a second year—the only man in the history of the Society to be so honored.

The established condition that the investigator should be chosen and the report approved and issued by the Foundation (the Committee of Educators and Engineers served merely as consultants and advisers) governed the Mann study. In the new project, however, full authority was vested in the Society for the Promotion of Engineering Education, including selection of staff, conduct of the enterprise, form and contents of reports. This was evidence of the growing respect for and confidence in the Society.

To quote from the paper, Engineering Education—the Present, by Dean Potter at the Chicago Meeting of 1943:

"The Investigation of Engineering Education, conducted by the Society for the Promotion of Engineering Education, 1923 to 1929, and the Summer Schools for Engineering Teachers, 1927–1933, which resulted from this investigation, had a most beneficial effect, not only upon engineering curricula and methods of instruction, but also upon engineering educational policies and practices and upon the cooperative relationships between the engineering colleges, industry and the engineering profession.

"This investigation stimulated interest in engineering educational problems, both in engineering colleges and on the part of engineers. Committees of the major engineering societies aided in securing the counsel of professional engineers regarding educational policies and practices.

Teachers scrutinized their classroom and laboratory practices, and were ready to draw upon the experiences of their colleagues in other colleges and upon those of practicing engineers and industrial leaders. Engineers from practice had major places on the programs of the Summer Schools for engineering teachers.

"This S.P.E.E. investigation gave the greatest and most beneficial impetus to engineering education which it has received throughout its entire history."

Summer Schools

There were twelve sessions of the Summer School for Teachers of Engineering Schools. Two of these sessions were held during the summer of 1927. Each session continued for three weeks. Programs included lectures, model teaching exercises, laboratory and lecture room demonstrations, seminars, and work carried out by committees of members of the groups. Both sessions of the first summer were devoted to mechanics. Later sessions covered subjects of electrical engineering, mechanical engineering, civil engineering, chemical engineering, mining and metallurgical engineering, engineering drawing, physics, mathematics, economics, and English. The total enrollment was 721, an average of 60 teachers for each session. The members of the staff totaled 376, an average of 32 for each session. The average number of institutions represented at each session was 41.

The Editor of the American Society of Mechanical Engineers, a former teacher and a member of the Council of The Society for the Promotion of Engineering Education, attended the Summer School for Mechanical Engineering. He reports (condensed):

"To evaluate the results one must give substance to many intangibles. A golden opportunity for the young instructor, subjects were presented in a new light, old problems were given new significance, and inspired enthusiasm, sectionalism was dissipated; teaching problems are fundamentally the same. Fortunate the college whose faculty has the more mature outlook the Summer School affords; notwithstanding this more than half of those attending received no expense funds from their schools.

"Engineering societies have a stake—their future is determined by the quality of graduates the schools produce; hence they are concerned with the sort of teachers who train engineers. For three weeks deans, professors and instructors lived together, ate together, sat together in class rooms, 90 of them came from 60 institutions in 36 states and two Canadian Provinces.

"The staff selected from colleges and industries contributed a rich program. The program at times simultaneously dealt with heat power, machine design and production; these were handled by experts interested in the teaching of these subjects.

"Some impressions: A reassuring conviction that teachers of engineering are on the right track. In an age of sudden changes and new environment methods of education change; engineering teachers have preserved a conservative balance with progressive vision. They are unique in boldly questioning their aims, ideals and methods with the hope of improving themselves, their schools and their product. They have been unique among teachers in the thoroughness of their studies and in definite formulation of their essential ideas. Colleges of liberal arts with varied program have not worked out definite plans as their objectives lack the definiteness which gives form to the engineering curriculum and the educational needs of the graduate engineer."

Technical Institutes

The very comprehensive Study of Technical Institutes, made under the

direction of the Board of Investigation and Coordination as a collateral project to its investigation of engineering education and published in 1931, has had a wide influence. The study considered that large but little cultivated field of education that lies between the secondary schools and the degree-granting colleges. Technical institutes, few in number and under one name or another, in various parts of the country, have given significant service in providing intensive and shortened curricula to fit men as engineering aids, foremen, technicians, and for other positions for which a full undergraduate engineering college course is not needed.

In the course of the study a fair cross section of industries reported that their needs for men with this abbreviated training far exceeded their requirements for college graduates. One of the conclusions reached was that numbers of men who have entered engineering colleges could have profited more from technical institute courses which stressed "theory" less and "doing" more.

Thirteen years later, in June 1944, we find this S.P.E.E. study used as the basis for the section entitled, TECHNICAL INSTITUTES, of Bulletin No. 228, of Federal Security Agency, U. S. Office of Education, upon Vocational-Technical Training for Industrial Occupations. In referring to this Study of Technical Institutes by the Society for the Promotion of Engineering Education, this government Bulletin says:

Of the various types of institutions which today are providing training of vocational-technical type, the one which appears to concentrate its attention most directly on the training of technicians is the technical institute, as defined in A Study of Technical Institutes. *No discussion of technical institutes, at the present time, would be complete without considerable reference to this study, made by the Society for the Promotion of Engineering Education, and published, in 1931. Most of its findings are as pertinent today as they were at the time of publication. A brief but fairly complete summary of this study is presented here. Toward the end of this section of the report is presented a summary of the trends and developments in technical institute education since the publication of the S.P.E.E. Study, prepared by Robert H. Spahr, one of the authors of the Study.*

"Technical education in the United States has grown up with little unifying philosophy. The engineering college has become a strongly defined type of institution. The trade schools are acquiring a typical character and standing. The gap between these types, typified in Great Britain by the 'local technical institution' and in continental Europe by the 'technical middle school,' has little counterpart in America. This study deals with this gap."

The original study by the Society and the supplementary Government study have aroused a demand for a very considerable expansion in the number of technical institutes as a postwar development. The anticipated expansion of American industry and the plans for the training of veterans are giving considerable impetus to this movement.

LAMME MEDAL

Provision for a Society medal was made by the will of Benjamin G. Lamme, formerly Chief Engineer for the Westinghouse Electric and Manufacturing Company to advance the engineering profession by encouraging good technical teaching.

The first award of the Benjamin G. Lamme gold medal "for accomplishment in technical teaching or actual

advancement of the art of technical training" was made to George Fillmore Swain of Harvard, at the Chapel Hill Meeting, June 27, 1928.

Engineers' Council for Professional Development

In 1932, the Society joined with American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers and National Council of State Boards of Engineering Examiners, in founding the Engineers' Council for Professional Development. The Engineering Institute of Canada was elected a Participating Body of E.C.P.D. on October 24th, 1940.

The motives that actuated the founding of E.C.P.D. are defined in Section 2, of its Charter:

2. *Objectives.* The general objective of E.C.P.D. is the enhancement of the professional status of the engineer. To this end it aims to coordinate and promote efforts and aspirations directed toward higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems.

An immediate objective, now apparently practicable of attainment, is the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, through the development of technical and other qualifications which will enable him to meet minimum professional standards.

The activities of E.C.P.D. are carried on mainly through the work of its Committees on Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recognition. It is generally considered to represent the "first concrete expression of general professional consciousness." One of its major achievements has been a program of accreditation for engineering schools.

The 1940 Report

For some time prior to the annual meeting of June, 1939, there had been considerable discussion concerning the most desirable length of undergraduate engineering curriculum in view of scientific and technological developments, as well as of educational thought. Some advocated "a preliminary period of study in schools of liberal arts before admission to the engineering school."

At the June meeting of 1939, the Committee on Aims and Scope of Engineering Curricula was therefore authorized. It made its report early the following year. This is referred to as the 1940 Report. Among its conclusions is:

"Considering only those young people to whom the education given by an engineering college is well adapted, we believe that their needs cannot properly be met by a program of uniform length, although we are convinced that the course leading to the bachelor's degree conforms well to the interest and career requirements of a large proportion of these students. For many of this group graduation represents a genuine limit of time and of means available for formal education; for many it represents also a scholastic attainment satisfying their tastes and native endowments. Moreover, this level of attainment conforms well to the personal requirements of many service functions in industry, in engineering organizations, and in government agencies. We believe the imposition of a

longer college program on all engineering students through a prescribed five-or-six-year course would be inconsistent with the financial resources, career needs, and abilities of many of this large group."

The Committee registered also its belief "that there are advantages in the parallel development of the *scientific-technological* and the *humanistic-social* sequences of engineering education." The Committee favored the parallel and continued teaching of each of these stems throughout all the undergraduate years.

It would be difficult to improve upon the following analysis of this report, which was made by Dean Potter in 1943:

The conclusions and recommendations in the *Report of S.P.E.E. Committee on Aims and Scope of Engineering Curricula,* made in 1940, represent a type of educational philosophy which has been most helpful in bringing about a continued process of refinement in engineering education, while encouraging engineering colleges to "serve diverse functions and prepare men for a wide range of technical, administrative, and executive responsibilities." This report was most timely in encouraging " the present flexible arrangement of four-year under-graduate curricula followed by post-graduate work" in place of "longer under-graduate curricula of uniformly prescribed duration." The parallel development in engineering education of the "scientific-technological" and the "humanistic-social" stems or sequences, as advocated in this report, is a suitable guide-post for engineering education in the post-war period."

The 1944 Report

The Committee on Engineering Education After the War, appointed in 1943, took up a further study under a directive: "to study the urgent problems of the immediate future as well as longer range problems of educational principle and practice, and particularly to review the 1940 Report on Aims and Scope of Engineering Curricula in the light of future conditions as they can now be envisaged."

Part I of their Report published in the May, 1944, Journal discusses "Purposes and Problems of Engineering Education." Part II deals with "Matters of Immediate Concern." Part I opens with the basic concept that "The purposes and problems of engineering education hinge on its two major responsibilities. One of these, which determines its aims and standards, is to the public, industry, and the profession it serves. The other, which determines its methods, is to the students as individuals. Later it says:

"The specific purposes implied here are of broad scope and are essentially those recommended in the 1940 Report on Aims and Scope of Engineering Curricula. They include training in the sciences basic to engineering, the rudimentary development of certain technical skills, as introduction to the engineering method of solving problems of practice, an understanding of values and costs, a sense of the art of engineering as distinguished from its science, the ability to read, write, and speak the English language effectively, a knowledge of social and human relationships, an understanding of the duties of citizenship, an appreciation of cultural interests outside the field of engineering, and indoctrination in professional standards and relations. Inherent in the accomplishment of these purposes is the development in the student of habits of accuracy and thoroughness, powers of analysis, creative ability, respect for facts, and high standards of integrity with respect to all aspects of his work."

The report recommends that undergraduate engineering curricula be developed, as rapidly as may be practicable, to provide for three major groups of students: 1. Those who look upon the study of engineering as being most suitable to them as education for the more or less general activities of the careers they expect to enter. 2. Those preparing for careers in the operation and management of industry. 3. Those who would be fitted for unusual scientific and creative accomplishments. It places major emphasis upon methods of engineering thought, discipline in engineering habits of work and indoctrination in the ideals and ethics of the engineering profession.

Much of the report is devoted to considerations and recommendations regarding the basic areas of engineering education, such as the scientific-technological and the humanistic-social stems. It indicates that considerations of improvement and development can be approached most readily under these two headings and also under graduate study and research. The great challenge before the Society for the immediate future is the study and implementation of the recommendations of this report.

ORGANIZATION OF THE SOCIETY

The Society for the Promotion of Engineering Education was the outgrowth of the meetings of Division E of the World's Engineering Congress held in Chicago from July 21 to August 15, 1893, in connection with the World's Columbian Exposition.

The aim of the Society is the promotion of the highest ideals in the conduct of engineering education with respect to administration, curriculum, and teaching work, and the maintenance of a high professional standard among its members.

The means to this end include educational research, the holding of meetings for the reading and the discussion of professional papers, and the publication of papers, discussions, and communications as may seem expedient.

Each Society member should scrutinize carefully the membership list for his institution, as published in this year book, and interest his colleagues, who are not members, in Society membership.

OFFICERS, COUNCIL MEMBERS, AND COMMITTEES OF THE SOCIETY FOR 1944–45

COUNCIL

OFFICERS 1944–45

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H. S. ROGERS, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

First Vice President

N. W. DOUGHERTY, University of Tennessee, Knoxville, Tenn.

Second Vice President

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Assistant Secretary

NELL MCKENRY, University of Pittsburgh, Pittsburgh 13, Pa.

COUNCIL

I. Elective Members

Terms Expire in 1945

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J. C. ELGIN, Princeton University, Princeton, N. J.
L. J. FLETCHER, Caterpillar Tractor Co., Peoria, Ill.
C. E. LAWALL, West Virginia University, Morgantown, W. Va.
R. L. SPENCER, University of Delaware, Newark, Del.
C. E. TUCKER, Massachusetts Institute of Technology, Cambridge, Mass.
JOSEPH WEIL, University of Florida, Gainesville, Fla.

Terms Expire in 1946

E. L. ERIKSEN, University of Michigan, Ann Arbor, Mich.
W. O. HOTCHKISS, Rensselaer Polytechnic Institute, Troy, N. Y.
THORNDIKE SAVILLE, New York University, New York City.
R. H. SPAHR, General Motors Inst. Tech., Flint, Mich.
G. L. SULLIVAN, University of Santa Clara, Santa Clara, Calif.
F. L. WILKINSON, University of Louisville, Louisville, Ky.
W. R. WOOLRICH, University of Texas, Austin, Texas.

Terms Expire in 1947

H. O. CROFT, University of Iowa, Iowa City, Iowa
R. A. DELLER, 463 West St., New York City
F. W. GARRAN, Dartmouth College, Hanover, N. H.
A. F. GREAVES-WALKER, North Carolina State College, Raleigh, N. C.
E. A. LOEW, University of Washington, Seattle, Wash.
F. C. VILBRANDT, Virginia Polytechnic Institute, Blacksburg, Va.
W. C. WHITE, Northeastern University, Boston, Mass.

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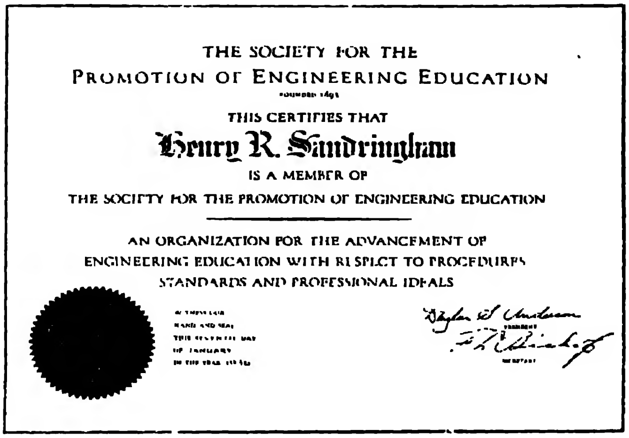
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THE AMERICAN SOCIETY OF CIVIL ENGINEERS, George T. Seabury, Secretary, 33 West 39th Street, New York City 1939

UNIVERSITY OF ARIZONA, Tucson, Ariz., Alfred Atkinson, President, G. M. Butler, Dean 1914

UNIVERSITY OF ARKANSAS, Fayetteville, Ark., A. M. Harding, President, George P. Stocker, Dean 1921

BRADLEY POLYTECHNIC INSTITUTE, Peoria, Ill., F. R. Hamilton, President, Geo. F. Branigan, Dean 1943

POLYTECHNIC INSTITUTE OF BROOKLYN, Brooklyn, N. Y., H. S. Rogers, President, Erich Hausmann, Dean 1921

BROWN UNIVERSITY, Providence, R. I., Henry M. Wriston, President, Leighton T. Bohl, Chairman 1914

BUCKNELL UNIVERSITY, Lewisburg, Pa., Herbert L. Spencer, President, G. A. Irland, Chairman of Engineering Group 1925

CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, Calif., Robert A. Millikan, Chairman, Executive Council; Franklin Thomas, Chairman of Engineering Division 1913

UNIVERSITY OF CALIFORNIA, Berkeley, Calif., Robert G. Sproul, President, M. P. O'Brien, Dean 1937

CARNEGIE INSTITUTE OF TECHNOLOGY, Pittsburgh, Pa., Robert E. Doherty, President, W. N. Jones, Director 1915

CASE SCHOOL OF APPLIED SCIENCE, Cleveland, Ohio, Wm. E. Wickenden, President, Elmer Hutchisson, Dean 1913

CATHOLIC UNIVERSITY OF AMERICA, Washington, D. C., Patrick J. McCormick, Rector, A. J. Scullen, Dean 1917

UNIVERSITY OF CINCINNATI, Cincinnati, Ohio, Raymond Walters, President, R. C. Gowdy, Dean 1917

THE CITADEL, THE MILITARY COLLEGE OF SOUTH CAROLINA, Charleston, S. C., C. P. Summerall, President, L. S. LeTellier, Dean 1914

CLARKSON COLLEGE OF TECHNOLOGY, Potsdam, N. Y., J. A. Ross, Jr., President 1938

CLEMSON AGRICULTURAL COLLEGE, Clemson, S. C., Robert F. Poole, President, S. B. Earle, Dean 1918

* Active institutional members are accredited engineering colleges and distinguished national engineering societies.

COLORADO SCHOOL OF MINES, Golden, Colo., Melville F. Coolbaugh, President, Jesse R. Morgan, Dean 1929

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE, Fort Collins, Colo., Roy M. Green, President, N. A. Christensen, Dean 1923

UNIVERSITY OF COLORADO, Boulder, Colo., R. G. Gustavson, President, C. L. Eckel, Dean 1915

COLUMBIA UNIVERSITY, New York City, N. M. Butler, President, Joseph W. Barker, Dean 1923

UNIVERSITY OF CONNECTICUT, Storrs, Conn., A. N. Jorgensen, President, ——— ——, Dean 1941

THE COOPER UNION, New York City, Edwin S. Burdell, Director, G. F. Bateman, Dean 1927

CORNELL UNIVERSITY, Ithaca, N. Y., Edmund Ezra Day, President, S. C. Hollister, Dean 1913

UNIVERSITY OF DELAWARE, Newark, Del., W. O. Sypherd, Acting President, R. L. Spencer, Dean 1916

UNIVERSITY OF DENVER, Denver, Colo., Ben M. Cherrington, Chancellor, C. M. Knudson, Dean 1941

UNIVERSITY OF DETROIT, Detroit, Mich., William Millor, President, C. J. Freund, Dean 1924

DREXEL INSTITUTE OF TECHNOLOGY, Philadelphia, Pa., R. C. Disque, Acting President, J. Harland Billings, Acting Dean 1914

DUKE UNIVERSITY, Durham, N. C., R. L. Flowers, President, W. H. Hall, Dean 1932

ECOLE POLYTECHNIQUE, Montreal, Canada, Augustin Frigon, President, Armand Circé, Dean 1917

ENGINEERING INSTITUTE OF CANADA, THE, 2050 Mansfield Street, Montreal, Canada, L. Austin Wright, Secretary 1924

UNIVERSITY OF FLORIDA, Gainesville, Fla., John J. Tigert, President, Joseph Weil, Dean 1928

GEORGE WASHINGTON UNIVERSITY, Washington, D. C., Cloyd Heck Marvin, President, F. M. Feiker, Dean 1913

GEORGIA SCHOOL OF TECHNOLOGY, Atlanta, Ga., B. R. Van Leer, President, D. P. Savant, Dean 1913

THE GRADUATE SCHOOL OF ENGINEERING, Harvard University, Cambridge, Mass., James Bryant Conant, President, Harald M. Westergaard, Dean 1919

UNIVERSITY OF IDAHO, Moscow, Idaho, H. C. Dale, President, J. E. Buchanan, Dean on leave, L. C. Cady, Acting Dean 1924

ILLINOIS INSTITUTE OF TECHNOLOGY, Chicago, Ill., Henry T. Heald, President, J. C. Peebles, Dean 1921

UNIVERSITY OF ILLINOIS, Urbana, Ill., A. C. Willard, President, M. L. Enger, Dean 1914

IOWA STATE COLLEGE, Ames, Iowa, Charles E. Friley, President, T. R. Agg, Dean 1913

STATE UNIVERSITY OF IOWA, Iowa City, Iowa, Virgil M. Hancher, President, F. M. Dawson, Dean 1914

JOHNS HOPKINS UNIVERSITY, Baltimore, Md., Isaiah Bowman, President, W. B. Kouwenhoven, Dean 1921

KANSAS STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE, Manhattan, Kans., Milton S. Eisenhower, President, R. A. Seaton, Dean 1917

THE UNIVERSITY OF KANSAS, Lawrence, Kans., Deane W. Malott, Chancellor, J. O. Jones, Dean 1914

UNIVERSITY OF KENTUCKY, Lexington, Ky., H. L. Donovan, President, James H. Graham, Dean 1925

LAFAYETTE COLLEGE, Easton, Pa., William Mather Lewis, President, W. S. Lohr, Chairman, Engineering Committee 1915
LEHIGH UNIVERSITY, Bethlehem, Pa., Administrative Committee: Deans P. M. Palmer, Chairman, Neil Carothers, A. C. Callen 1914
LOUISIANA STATE UNIVERSITY, University, La., W. B. Hatcher, President, L. J. Lassalle, Dean 1934
UNIVERSITY OF LOUISVILLE, Louisville, Ky., E. W. Jacobsen, President, F. L. Wilkinson, Dean 1925
MCGILL UNIVERSITY, Montreal, Canada, F. Cyril James, Principal, J. J. O'Neil, Dean 1924
UNIVERSITY OF MAINE, Orono, Me., Arthur A. Hauck, President, Paul Cloke, Dean 1917
MANHATTAN COLLEGE, New York City, Rev. Bro. Bonaventure Thomas, President, Rev. Bro. A. Leo, Dean 1933
MARQUETTE UNIVERSITY, Milwaukee, Wis., Peter A. Brooks, President, William D. Bliss, Dean 1919
UNIVERSITY OF MARYLAND, College Park, Md., H. C. Byrd, President, S. S. Steinberg, Dean 1923
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass., K. T. Compton, President, E. L. Moreland, Dean 1918
MICHIGAN COLLEGE OF MINING AND TECHNOLOGY, Houghton, Mich., Grover C. Dillman, President, James Fisher, Dean 1914
MICHIGAN STATE COLLEGE, East Lansing, Mich., John A. Hannah, President, H. B. Dirks, Dean 1933
UNIVERSITY OF MICHIGAN, Ann Arbor, Mich., Alex G. Ruthven, President, Ivan C. Crawford, Dean 1913
UNIVERSITY OF MINNESOTA, Minneapolis, Minn., Walter C. Coffey, President, Samuel C. Lind, Dean 1919
MISSISSIPPI STATE COLLEGE, State College, Miss., G. D. Humphrey, President, L. L. Patterson, Dean 1939
UNIVERSITY OF MISSOURI, Columbia, Mo., F. A. Middlebush, President, H. A. Curtis, Dean 1914
MISSOURI SCHOOL OF MINES AND METALLURGY, Rolla, Mo., F. A. Middlebush, President, Curtis L. Wilson, Dean 1925
MONTANA SCHOOL OF MINES, Butte, Mont., F. A. Thomson, President, A. E. Adami, Dean 1938
MONTANA STATE COLLEGE, Bozeman, Mont., R. R. Renne, President, E. W. Schilling, Dean 1923
UNIVERSITY OF NEBRASKA, Lincoln, Nebr., C. A. Boucher, Chancellor, O. J. Ferguson, Dean 1914
UNIVERSITY OF NEVADA, Reno, Nev., John O. Moseley, President, S. G. Palmer, Dean 1943
NEWARK COLLEGE OF ENGINEERING, Newark, N. J., Allan R. Cullimore, President, R. W. Van Houten, Dean 1922
UNIVERSITY OF NEW BRUNSWICK, Fredericton, N. B., Milton F. Gregg, President, John Stephens, Dean 1923
UNIVERSITY OF NEW HAMPSHIRE, Durham, N. H., Harold W. Stoke, President, G. W. Case, Dean (on leave of absence); L. W. Hitchcock, Acting Dean 1923
NEW MEXICO COLLEGE OF A. & M. ARTS, State College, N. M., John W. Branson, Acting President, D. B. Jett, Dean 1917
UNIVERSITY OF NEW MEXICO, Albuquerque, N. M., J. F. Zimmerman. President, M. E. Farris, Dean 1937
NEW YORK COLLEGE OF CERAMICS AT ALFRED UNIVERSITY, Alfred, N. Y., J. Nelson Norwood, President, Major E. Holmes, Dean 1938

THE COLLEGE OF THE CITY OF NEW YORK, New York, N. Y., H. N. Wright, President, A. B. Newman, Dean 1940

NEW YORK UNIVERSITY, New York, N. Y., Harry W. Chase, Chancellor, Thorndike Saville, Dean 1913

NORTH CAROLINA STATE COLLEGE OF THE UNIVERSITY OF NORTH CAROLINA, Raleigh, N. C., Frank P. Graham, President, J. W. Harrelson, Dean of Administration; J. H. Lampe, Dean of Engineering 1920

NORTH DAKOTA AGRICULTURAL COLLEGE, Fargo, N. D., F. L. Eversull, President, R. M. Dolve, Dean 1924

UNIVERSITY OF NORTH DAKOTA, Grand Forks, N. D., John C. West, President, L. C. Harrington, Dean 1913

UNIVERSITY OF NOTRE DAME, Notre Dame, Ind., Hugh O'Donnell, President, D. C. Jackson, Dean, R. J. Schubmehl, Acting Dean 1914

NORTHEASTERN UNIVERSITY, Boston, Mass., Carl S. Ell, President, W. C. White, Dean 1921

NORTHWESTERN UNIVERSITY, Evanston, Ill., Franklyn B. Snyder, President, O. W. Eshbach, Dean 1939

NORWICH UNIVERSITY, Northfield, Vt., Homer L. Dodge, President, A. E. Winslow, Dean 1938

OHIO STATE UNIVERSITY, THE, Columbus, O., H. L. Bevis, President, Charles E. MacQuigg, Dean 1921

STATE UNIVERSITY OF OKLAHOMA, Norman, Okla., George L. Cross, Acting President, W. H. Carson, Dean 1913

OKLAHOMA A. & M. COLLEGE, Stillwater, Okla., Henry G. Bennett, President, Philip S. Donnell, Dean, E. R. Stapley, Acting Dean 1933

OREGON STATE COLLEGE, Corvallis, Ore., A. L. Strand, President, G. W. Gleeson, Acting Dean 1917

THE PENNSYLVANIA STATE COLLEGE, State College, Pa., R. D. Hetzel, President, H. P. Hammond, Dean 1914

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; George W. McClelland, President: Moore School of Electrical Engineering, Harold Pender, Dean 1930

Towne Scientific School, John A. Goff, Dean 1914

UNIVERSITY OF PITTSBURGH, Pittsburgh, Pa., John G. Bowman, Chancellor, E. A. Holbrook, Dean 1913

PRATT INSTITUTE, Brooklyn, N. Y., Charles Pratt, Secretary, N. S. Hibshman, Director 1939

PRINCETON UNIVERSITY, Princeton, N. J., Harold Willis Dodds, President, K. H. Condit, Dean 1922

PURDUE UNIVERSITY, Lafayette, Ind., Edward Charles Elliott, President, A. A. Potter, Dean 1915

QUEEN'S UNIVERSITY, Kingston, Ont., Canada, R. C. Wallace, Principal and Vice Chancellor, D. S. Ellis, Dean 1922

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y., L. W. Houston, Director, M. A. Hunter, Dean 1922

RHODE ISLAND STATE COLLEGE, Kingston, R. I., Carl R. Woodward, President, Royal L. Wales, Dean 1913

RICE INSTITUTE, Houston, Tex., Edgar Odell Lovett, President, Harry B. Weiser, Dean 1924

UNIVERSITY OF ROCHESTER, Rochester, N. Y., Allan Valentine, President, H. W. Leet, Chairman, Exec. Com., Dept. of Engineering 1937

ROSE POLYTECHNIC INSTITUTE, Terre Haute, Ind., D. B. Prentice, President, Carl Wischmeyer, Vice President 1916

RUTGERS UNIVERSITY, New Brunswick, N. J., Robt. C. Clothier, President, P. H. Daggett, Dean 1914

UNIVERSITY OF SANTA CLARA, Santa Clara, Calif., Charles J. Walsh, President, G. L. Sullivan, Dean 1937
SOUTH DAKOTA STATE COLLEGE OF A. & M. ARTS, Brookings, S. D., Lyman E. Jackson, President, H. M. Crothers, Dean 1924
SOUTH DAKOTA STATE SCHOOL OF MINES, Rapid City, S. D., Jos. P. Connolly, President 1926
UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, Calif., R. B. von Kleinsmid, President, R. E. Vivian, Dean 1938
SOUTHERN METHODIST UNIVERSITY, Dallas, Texas, Umphrey Lee, President, E. H. Flath, Dean 1929
STANFORD UNIVERSITY, Stanford University, Calif., Donald B. Tresidder, President, Frederick E. Terman, Dean 1917
STEVENS INSTITUTE OF TECHNOLOGY, Hoboken, N. J., Harvey N. Davis, President, Frederic E. Camp, Dean 1913
SWARTHMORE COLLEGE, Swarthmore, Pa., John W. Nason, President, Scott B. Lilly, Chairman 1921
SYRACUSE UNIVERSITY, Syracuse, N. Y., William P. Tolley, Chancellor, Louis Mitchell, Dean 1913
UNIVERSITY OF TENNESSEE, Knoxville, Tenn., James D. Hoskins, President, N. W. Dougherty, Dean 1921
A. & M. COLLEGE OF TEXAS, College Station, Tex., Gibb Gilchrist, President, H. W. Barlow, Dean 1916
TEXAS TECHNOLOGICAL COLLEGE, Lubbock, Tex., William M. Whyburn, President, O. V. Adams, Dean 1931
UNIVERSITY OF TEXAS, Austin, Tex., T. S. Painter, Acting President, W. R. Woolrich, Dean 1919
THAYER SCHOOL OF ENGINEERING AT DARTMOUTH COLLEGE, Hanover, N. H., Ernest M. Hopkins, President, Frank W. Garran, Dean 1940
UNIVERSITY OF TOLEDO, Toledo, Ohio, P. C. Nash, President, John B. Brandeberry, Dean 1915
UNIVERSITY OF TORONTO, Toronto, Ont., Canada, H. J. Cody, President, C. R. Young, Dean 1917
TUFTS COLLEGE, Medford, Mass., Leonard Carmichael, President, H. P. Burden, Dean 1914
TULANE UNIVERSITY OF LOUISIANA, New Orleans, La., R. C. Harris, President, J. M. Robert, Dean 1921
UNIVERSITY OF TULSA, Tulsa, Okla., C. I. Pontius, President, R. L. Langenheim, Dean 1940
UNION COLLEGE, Schenectady, N. Y., President, H. W. Bibber, Chairman, Division of Engineering 1937
UNITED STATES COAST GUARD ACADEMY, New London, Conn., Rear Admiral James Pine, Supt., Capt. G. R. O'Connor, Head, Engineering Dept. .. 1939
UTAH STATE AGRICULTURAL COLLEGE, Logan, Utah, Elmer G. Peterson, President, G. D. Clyde, Dean 1940
UNIVERSITY OF UTAH, Salt Lake City, Utah, LeRoy E. Cowles, President, A. Leroy Taylor, Dean 1914
VANDERBILT UNIVERSITY, Nashville, Tenn., Oliver C. Carmichael, Chancellor, F. J. Lewis, Dean 1914
UNIVERSITY OF VERMONT, Burlington, Vt., John S. Millis, President, G. F. Eckhard, Dean 1915
VILLANOVA COLLEGE, Villanova, Pa., Francis X. N. McGuire, President, J. Stanley Morehouse, Dean 1921
VIRGINIA MILITARY INSTITUTE, Lexington, Va., C. E. Kilbourne, Superintendent, S. W. Anderson, Academic Executive 1937

Virginia Polytechnic Institute, Blacksburg, Va., Julian A. Burruss, President, E. B. Norris, Dean 1924
University of Virginia, University, Va., J. L. Newcomb, President, W. S. Rodman, Dean 1915
Washington University, St. Louis, Mo., Harry B. Wallace, Acting Chancellor, A. S. Langsdorf, Dean 1914
State College of Washington, Pullman, Wash., Wilson M. Compton, President, R. D. Sloan, Dean 1924
University of Washington, Seattle, Wash., Lee Paul Sieg, President, Edgar A. Loew, Dean 1934
Webb Institute of Naval Architecture, New York City, George H. Rock, Administrator, J. B. Blood, Dean 1937
West Virginia University, Morgantown, W. Va., C. E. Lawall, President, W. W. Hodge, Dean 1937
University of Wisconsin, Madison, Wis., ——————, President, F. Ellis Johnson, Dean 1914
Worcester Polytechnic Institute, Worcester, Mass., Wat T. Cluverius, President, F. W. Roys, Dean 1913
University of Wyoming, Laramie, Wyo., J. L. Morrill, President, R. D. Goodrich, Dean 1925
Yale University, New Haven, Conn., Charles Seymour, President, S. W. Dudley, Dean 1917

Associate *

Arkansas Polytechnic College, Russellville, Ark., C. R. Nichols, Dean 1940
Bliss Electrical School, Takoma Park, Washington, D. C., Louis D. Bliss, President, Milton M. Flanders, Dean 1939
Chrysler Institute of Engineering, Detroit, Mich., John J. Caton, Director 1943
Fenn College, Cleveland, Ohio, C. V. Thomas, President, M. B. Robinson, Dean 1940
Franklin Technical Institute, Boston, Mass., B. K. Thorogood, Director 1940
University of Hawaii, Honolulu, T. H., G. M. Sinclair, President, A. R. Keller, Dean 1923
Howard University, Washington, D. C., M. W. Johnson, President, L. K. Downing, Dean 1937
Kansas State Teachers College, Pittsburg, Kansas, Rees H. Hughes, President, J. A. G. Shirk, Engineering Advisor 1937
Los Angeles Junior College, Los Angeles, Calif. R. C. Ingalls, Director, George W. Duncan, Chairman, Engineering Department 1937
Milwaukee School of Engineering, Milwaukee, Wis., Karl O. Werwath, Registrar 1943
New York State Agricultural and Technical Institute of Alfred University, Alfred, N. Y., T. A. Parish and W. C. Hinkle, Directors. 1943
Ohio Mechanics Institute, Cincinnati, Ohio, John T. Faig, President .. 1940
Ohio Northern University, Ada, Ohio, Robert Williams, President, J. A. Needy, Dean 1937
University of Porto Rico, Rio Piedras, P. R., R. G. Tugwell, Chancellor, R. M. Ramos, Dean 1920
Scranton-Keystone Junior College, La. Plume, Pa., B. S. Hollingshead, President, J. A. Strelzoff, Chairman 1937

* An associate member may become an active member when one or more of its curriculums are accredited by the E. C. P. D.

University of South Carolina, Columbia, S. C., L. T. Baker, Acting President, R. L. Sumwalt, Dean 1943

Southwestern Louisiana Institute, Lafayette, La., Joel L. Fletcher, President, G. G. Hughes, Dean 1944

Texas College of Arts & Industries, Kingsville, Texas, E. N. Jones, President, R. L. Peurifoy, Director 1937

Westinghouse Technical Night School, East Pittsburgh, Pa., R. A. McPherson, Manager 1924

Total institutional members:

Active	141
Associate	19
	160

INDIVIDUAL MEMBERS.

Revised to February 1, 1945

AAKHUS, THEODORE, Assistant Professor of Engineering Drawing, University of Nebraska, Lincoln, Nebr. 1933

ABBITT, WILLIAM H., Associate Professor of Physics, Northwestern University, Evanston, Ill. 1941

ABBUHL, FRED, Associate Professor of English, Rensselaer Polytechnic Institute, Troy, N. Y. 1939

ACKENHEIL, ALFRED C., Instructor in Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. 1941

ACKERMAN, ADOLPH J., Director of Engineering, Dravo Corporation, Neville Island, Pittsburgh, Pa. 1941

ADAMI, ARTHUR E., Dean of College, Professor and Head, Dept. of Mining Engineering, Montana School of Mines, Butte, Mont. 1943

ADAMS, ARTHUR S., Provost elect, Cornell University, Ithaca, N. Y. In military service 1931

ADAMS, DOUGLAS P., Assistant Professor of Graphics, Massachusetts Institute of Technology, Cambridge, Mass. 1941

ADAMS, FRANCIS J., Professor and Acting Head, Dept. of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1912

ADAMS, HENRY C., Associate Professor of Naval Architecture and Marine Engineering, University of Michigan, Ann Arbor, Mich. 1940

ADAMS, LYNDON O., Administrative Assistant, Northwestern University, Evanston, Ill. 1944

ADAMS, OTTO V., Dean of Engineering, Professor of Civil Engineering, Texas Technological College, Lubbock, Texas 1930

ADAMS, RALPH G., In charge of Courses, Franklin Technical Institute, Boston, Mass. 1940

ADAMS, THOMAS C., 242 S. 12th St. E., Salt Lake City, Utah 1930

ADAMS, WILLIAM E., Assistant Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1939

ADDISON, GRIFFITH T., Associate Professor of Coördination, University of Cincinnati, Cincinnati, Ohio 1943

AGER, RAYMOND W., Associate Professor of Electrical Engineering, Cornell University, Ithaca, N. Y. 1940

AGG, THOMAS R., Dean of Engineering, Director, Engineering Experiment Station, Iowa State College, Ames, Iowa 1923

AGTHE, FREDERICK T., Process Engineer, Allis-Chalmers Mfg. Co., P.O. Box 512, Milwaukee 1, Wis. 1944

AHLQUIST, ROBERT W., Associate Professor of Electrical Engineering, Iowa State College, Ames, Iowa 1929

AIKEN, HENRY B., Assistant Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn. 1937

AKERMAN, JOHN D., Professor and Head, Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn. 1931

AKEY, WAYNE W., Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. 1944

ALBERT, ARTHUR L., Professor of Communication Engineering, Oregon State College, Corvallis, Ore. 1929

ALBERT, CALVIN D., Professor Emeritus of Machine Design, Cornell University, Ithaca, N. Y. 1938

ALBRIGHT, JOHN G., Professor and Head, Dept. of Physics, Rhode Island State College, Kingston, R. I. 1944

ALBRIGHT, PENROSE S., Professor of Physics, University of Wichita, Wichita, Kans. 1932

ALDRICH, BENJAMIN M., Assistant Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1932

ALDRICH, MILTON H., Assistant Professor of Civil Engineering, University of Vermont, Burlington, Vt. 1939

ALEXANDER, DONALD C., Instructor in Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1944

ALEXANDER, NICHOLAS, Professor of Aeronautical Engineering, Rhode Island State College, Kingston, R. I. 1937

ALGER, PHILIP L., Staff Assistant to Engineering Vice President, General Electric Company, Schenectady, N. Y. 1925

ALGREN, AXEL B., Associate Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1929

ALLAN, WILLIAM, Associate Professor of Civil Engineering, College of the City of New York, New York City 1935

ALLEN, ALEXANDER J., Westinghouse Graduate Professor of Engineering, University of Pittsburgh, Pittsburgh, Pa. 1944

ALLEN, C. FRANK, Retired, 88 Montview St., West Roxbury, Mass. (*President, 1903–4; Secretary, 1895–7; Vice President, 1898–9; Member of Council since 1895.*) 1893

ALLEN, CHESTER L., Professor and Head, Dept. of Civil Engineering, Michigan State College, East Lansing, Mich. 1917

ALLEN, C. M., Professor of Hydraulic Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1903

ALLEN, ELBERT F., Professor of Mathematics, A. & M. College of Oklahoma, Stillwater, Okla. 1937

ALLEN, FORREST E., Assistant Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1943

ALLEN, GEORGE M., Associate Professor of Drafting, Executive Officer, Columbia University, New York, N. Y. 1941

ALLEN, ROBERT L., Associate Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1937

ALLEN, RUSSELL B., Associate Professor of Civil Engineering, University of Maryland, College Park, Md. 1937

ALLIASON, ALBERT R., Head and Associate Professor of Electrical Engineering, Wayne University, Detroit, Mich. 1938

ALLISON, WILLIAM H., Associate Professor of Civil Engineering, Clarkson College of Technology, Potsdam, N. Y. 1928

ALLURED, ROBERT B., Associate Professor of Electrical Engineering, Arkansas Polytechnic College, Russellville, Ark. **In military service** 1940

ALMSTEAD, FRANCIS E., Lieut., U. S. Naval Training School, Noroton Heights, Conn. **In military service** 1943

ALMY, LOREN B., Assistant Professor of Civil Engineering, University of North Dakota, Grand Forks, N. D. 1941

ALOYSIUS JOSEPH, BROTHER, Instructor in Civil Engineering, Manhattan College, New York City 1943

ALSMEYER, WILLIAM C., Senior Stress Analyst, Goodyear Aircraft Corp., Akron, Ohio 1943

AZEVEDO DO AMARAL, IGNACIO M., Director, Escola Nacional de Engenheria, Universidade do Brazil, Rua Voluntarios da Patria, 31, Rio de Janeiro, Brazil, S. A. 1943
AMBERG, CHARLES R., Head of Ceramic Research, New York State College of Ceramics, Alfred, N. Y. 1941
AMBROSIUS, EDGAR E., Head, Dept. of Mechanical Engineering, The Pennsylvania State College, State College, Pa. 1941
AMELOTTI, EMIL, Assistant Professor of Mathematics, Villanova College, Villanova, Pa. 1938
AMIDON, LEE L., Professor and Head, Dept. of Mechanical Engineering, South Dakota State College, Brookings, S. D. 1928
ANDEREGG, RUPERT A., Professor of Civil Engineering, University of Cincinnati, Cincinnati, Ohio 1943
ANDERSEN, PAUL, Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn. 1934
ANDERSON, C. A., Professor of Engineering, University of Pittsburgh, Johnstown Center, Johnstown, Pa. 1926
ANDERSON, C. EDWARD, Professor and Chairman, Dept. of Mechanical Engineering, University of Wyoming, Laramie, Wyo. 1928
ANDERSON, CLIFFORD O., Assistant Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1943
ANDERSON, D. S., Dean Emeritus, Tulane University; Ogunquit, Maine. *(Member of Council, 1926–9, 1935–; Vice President, 1931–32; President, 1935–36.)* 1900
ANDERSON, DICK R., Assistant Professor of English, Georgia School of Technology, Atlanta, Ga. 1944
ANDERSON, FRANK A., Assistant Professor of Chemistry and Chemical Engineering, University of Mississippi, University, Miss. 1944
ANDERSON, HAROLD W., Assistant Engineer, Electron Tube Application Section, General Electric Co., Schenectady, N. Y. 1925
ANDERSON, JOHN, Professor of Civil Engineering, The Citadel, Charleston, S. C. 1936
ANDERSON, NEWTON H., Assistant to Personnel Manager, Douglas Aircraft Co., Inc., Santa Monica, Calif. 1942
ANDERSON, VICTORIA, Associate in English, University of Washington, Seattle, Wash. 1939
ANDES, AMMON S., Research Lab., Analyst, Eng. Test Lab., Consolidated Vultee Aircraft Corp., Fort Worth, Texas 1937
ANDRAE, STEPHAN C., Assistant Electrical Engineer, Consolidated Steel Corp., Wilmington, 865 N. Mentor Ave., Pasadena, Calif. 1939
ANDREASSEN, ALEXANDER T., Instructor in Mechanics of Engineering, Cornell University, Ithaca, N. Y. 1943
ANDRES, PAUL G., Associate Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1941
ANDREWS, ANDREW I., Professor and Head, Dept. of Ceramic Engineering, University of Illinois, Urbana, Ill. 1943
ANDREWS, CARL B., Associate Professor of Civil Engineering, Michigan State College, East Lansing, Mich. 1925
ANDREWS, DONALD K., Supervisor, Tool Design, North American Aviation, Inc., 2603 Emmett St., Dallas, Texas 1943
ANDREWS, GORDON O., Manager, Personnel Division, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del. 1942
ANDREWS, STEPHEN C., Associate Professor of Business Administration, Virginia Polytechnic Institute, Blacksburg, Va. 1934

ANGERMANN, WILLIAM G., Associate Professor of Electrical Engineering, University of Southern California, Los Angeles, Calif. 1937

ANTHONY, RICHARD L., Professor of Mechanical Engineering, Rutgers University, New Brunswick, N. J. 1937

APPLEBY, ALFRED N., Assistant Professor of Drafting, College of the City of New York, New York City 1940

APPLEGATE, C. E., Field Engineer, Educational Division, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. 1941

ARCHER, LUTHER B., Assistant Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1944

ARDUSER, LEON P., Senior Training Officer, U. S. Veterans Administration, Montgomery, Ala. 1925

ARENSON, SAUL B., Professor of Inorganic-Chemistry, University of Cincinnati, Cincinnati, Ohio 1938

ARM, DAVID L., Professor and Head, Dept. of Mechanical Engineering, Iowa State College, Ames, Iowa 1934

ARMSBY, HENRY H., Field Coordinator, E. S. M. D. T., U. S. Office of Education, Washington, D. C. (*Member of Council, 1938–41*) 1917

ARMSTRONG, EDWIN H., Professor of Electrical Engineering, Columbia University, New York City 1937

ARMSTRONG, W. H., Instructor in Industrial Engineering, The Pennsylvania State College, State College, Pa. 1937

ARNOLD, JAMES E., Aeronautical Engineer, Consolidated Vultee Air Corp., 5168 35th St., San Diego, Calif. 1938

ARNOLD, J. NORMAN, Associate Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1933

ASHTON, MERTON E., Alumni Secretary, Norwich University, Northfield, Vt. 1940

ATKINSON, FREDERICK G., Col., Assistant Chief of Staff for Personnel, Air Transport Command, Washington, D. C. **In military service** 1937

ATKINSON, MARGARET B., Assistant Professor of Engineering Drawing, Texas Technological College, Lubbock, Texas 1937

ATTWOOD, STEPHEN S., Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1926

ATWOOD, L. L., Professor and Head, Dept. of Language and History, Worcester Polytechnic Institute, Worcester, Mass. 1939

AUBERT, BROTHER, Assistant Professor of Civil Engineering, Manhattan College, New York City 1935

AUBURN, NORMAN P., Dean of University Administration, University of Cincinnati, Cincinnati, Ohio 1942

AULICH, WITOLD M., Professor of Mechanology, Polytechnic of Lwow, ul. Dunin-Borkowskich 2, Lwow, Poland 1930

AULT, E. STANLEY, Professor of Machine Design, Purdue University, Lafayette, Ind. 1925

AUTEN, R. L., Director, Engineering Personnel Bureau, Curtiss-Wright Corp., 663 Main Ave., Passaic, N. J. 1944

AUTENREITH, GEORGE C., Professor of Drafting, College of the City of New York, New York City 1927

AUTH, GEORGE H., Associate Professor of Mechanical Engineering, Villanova College, Villanova, Pa. 1944

AVEY, HARRY T., Associate Professor of Mechanics, University of Wisconsin in Milwaukee, Wis. 1943

AX, LELAND S., Professor and Head, Radio Engineering, Tri-State College, Angola, Ind. 1943

AYER, FRED. E., Dean, College of Engineering and Commerce, University of Akron, Akron, O. (*Member of Council, 1933–36.*) 1907

AYERS, JOSEPH A., Associate Professor of English, University of Louisville, Louisville, Ky 1939

AYERS, MAURICE T., Assistant Professor of General Engineering, Rutgers University, New Brunswick, N. J. 1938

AYRE, ROBERT S., Associate Mechanical Engineer, Naval Ordnance Lab., Washington, D. C. 1926

AYRES, EDMUND D., Professor of Electrical Engineering, The Ohio State University, Columbus, Ohio 1934

AYRES, QUINCY C., Commander U. S. N. R., Bureau of Yards and Docks, Seattle, Wash. **In military service** 1926

AYRES, WILLIAM L., Professor of Mathematics, Purdue University, Lafayette, Ind. 1943

BABBITT, HAROLD E., Professor of Sanitary Engineering, University of Illinois, Urbana, Ill. 1922

BABCOCK, JOHN B., Professor of Railway Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1923

BABCOCK, M. M., Associate Professor of Industrial Engineering, Pennsylvania State College, State College, Pa. 1936

BACCUS, IRA B., Associate Professor of Electrical Engineering, Michigan State College, East Lansing, Mich. **In military service** 1942

BACKER, CARL M., Senior Radio Engineer, Aircraft Radio Lab., Wright Field, Dayton, Ohio 1944

BACKER, GERALD H., Associate Professor of Applied Mechanics, University of Kentucky, Lexington, Ky. 1943

BACKER, LESLIE H., Professor of Chemistry, Stevens Institute of Technology, Hoboken, N. J. 1930

BACKER, LOUIS B., Adjunct Professor of Electrical Engineering, Manhattan College, New York City 1936

BACON, RINALDO A., Instructor in Mechanical Engineering, University of Texas, Austin, Texas (U. S. Naval Academy, Annapolis, Md.) 1939

BADLEY, JOY E., President, Tractor Training Service, 406 Panama Bldg., Portland 4, Ore. 1944

BAGLEY, JAMES W., Lecturer in Aerophotography, Harvard University, Cambridge, Mass. 1942

BAIER, LOUIS A., Professor of Naval Architecture and Marine Engineering, University of Michigan, Ann Arbor, Mich. 1940

BAILEY, ALBERT D., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. **In military service** 1943

BAILEY, ALEX D., Assistant to Vice President, Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill. 1943

BAILEY, BENJ. F., Professor and Head, Dept. of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1920

BAILEY, CHARLIE R., Associate Chemical Engineer, Research & Development, The Atlantic Refining Co., 1009 Woowlawn Ave., Dallas 8, Texas 1942

BAILEY, JOEL F., Assistant Professor of Mechanical Engineering, Northwestern University, Evanston, Ill. 1943

BAILEY, NEIL P., Professor and Head, Dept. of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1930

BAILEY, RALPH E., Senior Electrical Engineer, Clinton Engineer Works, Tenn. Eastman Corp., Oak Ridge, Tenn. 1943

BAILEY, WAYLAND S., Assistant Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1937
BAIN, J. WATSON, Professor of Chemical Engineering, University of Toronto, Toronto, Canada 1943
BAINER, ROY, Associate Professor of Agricultural Engineering, University of California, Davis, Calif. 1933
BAKER, CHESTER P., Professor and Chairman, Dept. of Chemical Engineering, Northeastern University, Boston, Mass. 1926
BAKER, EDWARD G., Technical Staff, American Bureau of Shipping, 47 Beaver St., New York City 1934
BAKER, ELLIS G., Professor and Head, Dept. of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1925
BAKER, HENRY D., Instructor in Mechanical Engineering, Columbia University, New York City 1943
BAKER, RALPH A., Sales Manager, Standard Aircraft Workers' Manual, Fletcher Aircraft, P O. Box 1172, Hollywood, Calif. 1943
BAKER, RALPH D., Associate Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah 1940
BAKER, RAY P., Dean of Students, Rensselaer Polytechnic Institute, Troy, N. Y. 1919
BAKER, ROBERT H., Assistant Director, War Industries, Stevens Institute of Technology, Hoboken, N. J. 1943
BAKER, SAMUEL, Dean, Schools of Technology, International Correspondence Schools, Scranton, Pa. 1935
BAKER, WILFRED H., Assistant Professor of Civil Engineering, West Virginia University, Morgantown, W. Va. 1944
BAKHMETEFF, BORIS A., Professor of Civil Engineering, Columbia University, New York City 1937
BALINT, ANTHONY T., Research Engineer, Stewart-Warner Corp., Chicago, Ill. 1942
BALL, THEODORE R., Associate Professor of Chemistry, Washington University, St. Louis, Mo. 1930
BALLARD, LYMAN J., Professor of Engineering and Physics, Webb Institute of Naval Architecture, New York City 1939
BALSBAUGH, JAYSON C., Associate Professor of Electric Production and Distribution, Massachusetts Institute of Technology, Cambridge, Mass. 1938
BAMFORTH, FREDERIC R., Professor of Mathematics, The Ohio State University, Columbus, Ohio 1943
BANCHERO, JULIUS, Instructor in Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. 1943
BANGS, JOHN R., JR., General Manager, Industrial and Personnel Relations, Edward G. Budd Mfg. Co., Philadelphia, Pa. 1932
BANKS, CHARLES W., Head, Department of Applied Science, Wentworth Institute, Boston, Mass. 1937
BANTEL, E. C. H., Professor of Civil Engineering, Assistant Dean, University of Texas, Austin, Texas 1925
BARBER, WILLIAM J., Associate Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1937
BARCLAY, LELAND, Assistant Professor of Civil Engineering, University of Texas, Austin, Texas 1938
BARDSLEY, CLARENCE E., Engineer, Material Demobilization, U. S. Corps Engineers, Pittsburgh 19, Pa. 1937
BARDUCCI, CARLOS B., Director de Economia Escolar, Ministerio De Educacion Publica, Lima, Peru 1943

Barger, Edgar L., Professor of Agricultural Engineering, Iowa State College, Ames, Iowa 1943

Barker, Charles L., Assistant Professor of Hydraulic Engineering, Washington State College, Pullman, Wash. 1928

Barker, George J., Chairman, Dept. of Mining and Metallurgy, University of Wisconsin, Madison, Wis. 1935

Barker, Joseph W., Dean, Faculty of Engineering, Columbia University, New York, N. Y. (*Member of Council, 1935–8.*) 1926

Barlow, Howard W., Dean, School of Engineering, A. & M. College of Texas, College Station, Texas 1940

Barnard, Niles H., Associate Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. 1930

Barnard, W. N., Director, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y. (*Member of Council, 1923–6.*) 1910

Barnes, F. A., Professor Emeritus of Railroad Engineering, Cornell University, Ithaca, N. Y. 1904

Barnes, George E., Professor of Hydraulic and Sanitary Engineering, Head, Dept. of Civil Engineering, Case School of Applied Science, Cleveland, Ohio 1933

Barnes, John L., Member of Technical Staff, Bell Telephone Labs., 195 Broadway, New York City 1938

Barnes, John S., College Representative, John Wiley & Sons, Inc., 440 Fourth Ave., New York City 1940

Barnes, Ralph M., Professor of Industrial Engineering, Director of Personnel, State University of Iowa, Iowa City, Iowa 1929

Barnes, Wilson R., Assistant Professor of Chemical Engineering, University of Louisville, Louisville, Ky. 1939

Barnett, Brinkley, Associate Professor of Electrical Engineering, University of Kentucky, Lexington, Ky. 1943

Barnwell, George W., Professor of Economics of Engineering, Stevens Institute of Technology, Hoboken, N. J. 1932

Barre, Henry J., Professor and Head, Dept. of Agricultural Engineering, Purdue University, Lafayette, Ind. 1944

Barrett, Edward C., Technologist, The National Bureau of Standards, Washington, D. C. 1938

Barrett, Sampson K., Assistant Dean in charge of Evening Division; Professor of Electrical Engineering, New York University, New York City 1928

Barrows, H. K., Consulting Engineer, 6 Beacon St., Boston, Mass 1902

Barrows, W. E., Jr., Professor of Electrical Engineering, University of Maine, Orono, Me. 1908

Barry, John G., Assistant Professor of Electrical Engineering, Princeton University, Princeton, N. J. 1941

Barthel, Christopher E., Physicist, Naval Ordnance Laboratory, 203 Elmira St., S.W., Washington 20, D. C. 1944

Bartlam, Edward R., Principal, Ceylon Technical Schools, Colombo, Ceylon 1937

Bartlett, Grady W., Assistant Professor of Physics, North Carolina State College, Raleigh, N. C. **Service** 1937

Bartlett, Howard R., Head, Dept. of English and History, Massachusetts Institute of Technology, Cambridge, Mass. 1939

Bartlett, R. S., Principal, Gunnery School, Washington, Conn. 1941

Barton, Millard V., Professor of Aeronautical Engineering, University of Texas, Austin, Texas 1939

BARTOW, EDWARD, Professor of Chemistry and Chemical Engineering, State University of Iowa, Iowa City, Ia. 1921
BASKERVILL, WILLIAM H., Associate Professor of Chemical Engineering, University of Tennessee, Knoxville, Tenn. 1943
BASORE, CLEBURNE A., Professor of Chemical Engineering, Assistant Director, Engineering Experiment Station, Alabama Polytechnic Institute, Auburn, Ala. 1938
BASS, FREDERIC, Chairman, Department of Civil Engineering, University of Minnesota, Minneapolis, Minn. (*Member of Council 1918–21.*) .. 1908
BASS, LAWRENCE W., Director, Chemical Research, Air Reduction Co., and U. S. Industrial Chemicals, Inc., 60 East 42nd St., New York 17, N. Y. 1942
BATEMAN, GEORGE F., Dean, Schools of Engineering, Professor of Mechanical Engineering, The Cooper Union, New York City 1925
BATES, HERBERT T., Instructor in Chemical Engineering, Case School of Applied Science, Cleveland, Ohio 1941
BAUDER, FREDERICK W., Assistant Professor of Chemistry, Newark College of Engineering, Newark, N. J. 1943
BAUER, EDWARD E., Assistant Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1936
BAUER, F. S., Professor and Head, Dept. of Engineering Drawing and Machine Design, University of Colorado, Boulder, Colo. 1914
BAUER, GEORGE C., Chief Engineer, Curtiss Wright Technical Institute, Glendale, Calif. 1941
BAUER, JOHN V., Instructor in Civil Engineering, College of the City of New York, New York City 1940
BAUER, WM. M., Professor and Head, Dept. of Electrical Engineering, University of South Carolina, Columbia, S. C. 1933
BAUM, HARRY, Professor of Electrical Engineering, College of the City of New York, New York City 1927
BAUMGARTEN, WILLIAM L., Assistant Professor of Architecture, North Carolina State College, Raleigh, N. C. 1940
BAUMIESTER, THEODORE, JR., Professor of Mechanical Engineering, Columbia University, New York City 1935
BAUWENS, GEORGE O., Assistant Professor of Civil Engineering, University of Southern California, Los Angeles, Calif. 1941
BAXTER, ROBERT A., Associate Professor of Chemistry and Gas Engineering, Colorado School of Mines, Golden, Colo. 1925
BAYLESS, W. A., Head, Design Standards Group, Chance Vought Aircraft, Stratford, Conn. 1938
BAYLOR, JAMES E., Assistant Professor of Mechanical Engineering, University of New Mexico, Albuquerque, N. M. 1943
BEACH, ROBIN, Professor and Head, Dept. of Electrical Engineering, The Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1917
BEAL, GEORGE M., Professor of Architecture, University of Kansas, Lawrence, Kansas. **In military service** 1935
BEAL, ROBERT W., Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa. **In military service** 1937
BEAM, ROBERT E., Assistant Professor of Electrical Engineering, Northwestern University, Evanston, Ill. 1942
BEANE, JOHN A., Consulting Engineer, Buffalo, N. Y. 1943
BEATTY, FRED B., Associate Professor of Electrical Engineering, Colorado State College, Fort Collins, Colo. 1936
BEATTY, H. RUSSELL, Assistant to the President, Head, Dept. of Administrative Engineering, Pratt Institute, Brooklyn, N. Y. 1937

Beaver, J. L., Professor and Acting Head, Dept. of Electrical Engineering, Lehigh University, Bethlehem, Pa. 1914

Bebie, Jules, Professor of Chemical Engineering, Washington University, St. Louis, Mo. 1936

Bechtold, Carl W., Instructor in Mechanics, University of Alabama, Tuscaloosa, Ala. 1941

Beck, Lester E., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1931

Becker, Sylvanus A., Associate Professor of Civil Engineering, Lehigh University, Bethlehem, Pa. 1933

Beckwith, Thomas G., Mechanical Engineer, Gulf Research and Development Co., Pittsburgh, Pa. 1944

Beecher, Milton F., Director of Research, Norton Co., Worcester, Mass. 1944

Beese, Charles W., Head, Dept. of General Engineering, Purdue University, Lafayette, Ind. 1938

Begeman, Myron L., Professor of Mechanical Engineering, Supt. Engineering Shops, University of Texas, Austin, Texas 1937

Begg, Robert B. H., Professor of Civil Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1927

Behrens, Robert G., Manager, College Dept., Associated Technical Publications, 1555 W. 79th Street, Chicago, Ill. 1935

Behrent, Lewis F., Assistant Examiner, Engineering Unit, U. S. Civil Service Commission, Washington, D. C. 1944

Beisler, Walter H., Professor and Head, Dept. of Chemical Engineering, University of Florida, Gainesville, Fla. 1936

Beitler, Samuel R., Professor of Hydraulic Engineering, The Ohio State University, Columbus, Ohio 1926

Belknap, J. Harrison, Lt. Col., Air Corps, Hq., AAF, Washington, D. C. (*Member of Council, 1941–44.*) 1938

Bell, Norman R., Instructor in Electrical Engineering, Cornell University, Ithaca, N. Y. 1943

Belz, Charles J., Professor and Head, Dept. of Civil Engineering, University of Dayton, Dayton, Ohio 1929

Bencivenga, Pasquale, Instructor in Electrical Engineering, Pratt Institute, Brooklyn, N. Y. 1943

Benedict, Otis, Jr., Assistant Professor of Shop Practice, Pratt Institute, Brooklyn, N. Y. 1929

Benedict, R. Ralph, Associate Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1939

Benford, Wm. R., Assistant Professor of Civil Engineering, Brown University, Providence, R. I. **In military service** 1932

Benjamin, Curtis G., Vice President, McGraw-Hill Book Co., Inc., 330 W. 42d St., New York 18, N. Y. 1933

Benkert, Harry N., Assistant Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. 1938

Benner, J. Alfred, Associate Professor of Mathematics, Lafayette College, Easton, Pa. 1931

Bennett, Albert A., Professor of Mathematics, Brown University, Providence, R. I. **In military service** 1936

Bennett, Burney B., Associate Professor of Language, Michigan College of M. & T., Houghton, Mich. **In military service** 1943

Bennett, Clarence E., Professor and Head, Dept. of Physics, University of Maine, Orono, Me. 1939

Bennett, Earl F., Assistant Professor of Civil Engineering, University of Maine, Orono, Me. 1939

BENNETT, EDW., Professor Emeritus, University of Wisconsin, Madison, Wis. (*Member of Council, 1923–6; Vice President, 1929–30.*) 1909
BENNETT, HARRY F., District Engineer, Dept. of Public Works, Box 668, London, Ont., Canada 1940
BENNETT, J. GARDNER, Associate Professor of Civil Engineering, University of Wyoming, Laramie, Wyo. 1932
BENNETT, RALPH D., Professor of Electrical Measurements, Massachusetts Institute of Technology, Cambridge, Mass. **In military service** .. 1937
BENNETT, W. H., Director of Applied Research, Institute of Textile Technology, Charlottesville, Va. 1939
BENSON, ARNOLD, Pecos Light and Power Co., Pecos, N. M. 1941
BENSON, FRED J., Acting Associate Professor of Civil Engineering, A. & M. College of Texas, College Station, Texas 1938
BENSON, LEONARD R., Assistant Professor of Mechanical Engineering, University of Texas, Austin, Texas 1939
BERARD, SAMUEL J., Associate Professor of Engineering Drawing, Brown University, Providence, R. I. 1912
BERESFORD, HOBART, Professor and Head, Department of Agricultural Engineering, University of Idaho, Moscow, Idaho 1929
BERG, HAROLD, Assistant Professor of Civil Engineering, Southern Methodist University, Dallas, Texas 1943
BERGER, FRANZ A., Professor of Mechanical Engineering, Washington University, St. Louis, Mo. 1924
BERGGREN, WILLARD P., Assistant Physicist, Agricultural Experiment Station, University of California, Davis, Calif. 1934
BERKEL, HOWARD J., Instructor in Civil Engineering, Iowa State College, Ames, Iowa. **In military service** 1938
BERNIER, JEAN C., Assistant Professor of Electrical Engineering and Communications, Ecole Polytechnique, Montreal, Canada 1942
BERRY, C. HAROLD, Gordon McKay Professor of Mechanical Engineering, Harvard University, Cambridge, Mass. 1928
BERRY, GEORGE M., Lecturer in Metallurgy, Instructor in Foundry Practice, Syracuse University, Syracuse, N. Y. 1941
BERRYMAN, LLOYD G., Chief Metallurgist, Lufkin Foundry & Machine Co., Lufkin, Texas 1939
BESSEY, WM. H., Instructor in Physics, Carnegie Institute of Technology, Pittsburgh, Pa. 1940
BEST, HERBERT W., Assistant Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1935
BETHEL, LAWRENCE L., Director, New Haven Y. M. C. A. Junior College, 15 Prospect St., New Haven, Conn. 1942
BETTENCOURT, WILLIAM, Instructor in Mechanical Drawing, Belmont Senior High School, Belmont, Mass. 1941
BEWLEY, L. V., Professor and Head, Dept. of Electrical Engineering, Lehigh University, Bethlehem, Pa. **In military service** 1940
BIBB, SAMUEL F., Associate Professor of Mathematics, Illinois Institute of Technology, Chicago, Ill. 1935
BIBBER, HAROLD W., Chairman, Engineering Division, Union College, Schenectady, N. Y. 1922
BIBERSTEIN, FRANK A., Associate Professor of Civil Engineering, Catholic University of America, Washington, D. C. 1943
BIEGLER, PHILIP S., Professor and Head, Dept. of Electrical Engineering, University of Southern California, Los Angeles, Calif. 1925
BIGELOW, ROYAL G., Associate Professor of Industrial Engineering, Northwestern University, Evanston, Ill. 1943

BILLHARTZ, WILLIAM H., Professor of Physics, Franklin College, Franklin, Ind. 1943

BILLINGS, ERLE M., Business and Technical Personnel Director, Eastman Kodak Co., 343 State St., Rochester, N. Y. 1940

BILLINGS, J. HARLAND, Professor and Head, Dept. of Mechanical Engineering, Acting Dean, Drexel Institute, Philadelphia, Pa. 1919

BILLMYER, CARROLL D., Associate Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. 1917

BINDER, RAYMOND C., Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1940

BINGHAM, LLOYD A., Associate Professor of Electrical Engineering, University of Colorado, Boulder, Colo. 1933

BIRCH, R. E., Research Engineer, Harbison-Walker Refining Co., Pittsburgh, Pa. 1942

BIRD, H. C., Professor of Civil Engineering, Duke University, Durham, N. C. 1914

BIRD, JAMES P., Instructor in Engineering, Kansas City Junior College, Kansas City, Mo. 1943

BIRD, JOHN M., Assistant Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn. 1943

BIRGE, RAYMOND T., Professor and Chairman, Dept. of Physics, University of California, Berkeley, Calif. 1939

BIRK, W. OTTO, Professor and Head, Dept. of English, University of Colorado, Boulder, Colo. (*Member of Council, 1940–43.*) 1920

BIRKNESS, HAROLD A., Instructor in Mechanical Engineering, Iowa State College, Ames, Iowa 1943

BISCHOF, GUSTAVE J., Associate Professor of Mechanical Engineering, College of the City of New York, New York, N. Y. 1931

BISHOP, CHARLES A., Associate Professor of Chemical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1943

BISHOP, C. T., Associate Professor of Structural Engineering, Yale University, New Haven, Conn. 1912

BISHOP, FRANCIS F., Professor of Chemical Engineering, A. & M. College of Texas, College Station, Texas 1938

BISHOP, F. L., Professor of Physics, University of Pittsburgh, Pittsburgh, Pa. (Life Member.) (*Secretary, 1914–; Member of Council, 1912–; Secretary, Board of Investigation and Coördination, 1922–33.*) 1907

BISHOP, WALTER W., Staff Assistant for Industrial Relations Counselors, Inc., 1270 Sixth Ave., New York 20, N. Y. 1940

BISSELL, G. W., Emeritus, Dean of Engineering, Michigan State College, 169 N. Magnolia St., Monrovia, Calif. (*Member of Council, 1899–02; 1910–13.*) 1894

BIXBY, FREDERICK L., Professor and Head, Dept. of Civil Engineering, University of Nevada, Reno, Nev. 1939

BIXLER, ROY W., Senior Educational Statistician, ESMWT, U. S. Office of Education, Washington, D. C. 1944

BJERG, HARTWIG O., Instructor in Industrial Arts, Arizona State Teachers College, Flagstaff, Ariz. 1940

BLACK, CLIFFORD H., Assistant Professor of Drawing, Missouri School of Mines, Rolla, Mo. 1943

BLACK, LOREN T., Instructor in Mathematics, University of California at Los Angeles, Calif. 1935

BLACK, PAUL H., Associate Professor of Machine Design, Cornell University, Ithaca, N. Y. 1936

BLACK, R. M., Professor and Head, Department of Mining, University of Pittsburgh, Pittsburgh, Pa. 1912
BLACK, RALPH P., Associate Professor of Civil Engineering, Georgia School of Technology, Atlanta, Ga. 1935
BLACKBURN, HENRY W., Associate Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y. 1928
BLAISDELL, A. H., Associate Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1921
BLAKE, ROLAND P., Senior Safety Engineer, Division of Labor Standards, U. S. Department of Labor, Washington, D. C. 1944
BLAKELEY, JAMES E., Director and General Manager, Brazilian Division, Embry-Riddle School of Aviation, Sao Paulo, Brazil 1943
BLAKESLEE, L. ROBERT, Associate Professor and Acting Head, Dept. of Architectural Engineering, University of Detroit, Detroit, Mich. ... 1935
BLALOCK, GROVER C., Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1918
BLEEKMAN, GEORGE M., Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1943
BLENKUSH, PHILIP G., Instructor in Aeronautics, University of Detroit, Detroit, Mich. c/o Andrew Blenkush, Route 1, St. Joseph, Minn. 1942
BLICKENSDERFER, HERMAN, Assistant Professor of Civil Engineering, University of Texas, Austin, Texas 1942
BLISS, COLLINS P., Dean, Emeritus, New York University, Eton Hall, Garth Road, Scarsdale, N. Y. 1915
BLISS, HOWARD H., Head of Physics Department, Riverside Junior College, Riverside, Calif. 1923
BLISS, JOHN C., Dean, School of Engineering, Robert College, Istanbul, Turkey 1944
BLISS, WARREN H., Research Engineer, RCA Laboratories, Riverhead, N. Y. 1933
BLISS, WILLIAM D., Dean, College of Engineering, Marquette University, Milwaukee, Wis. 1926
BLISS, ZENAS R., Professor of Applied Mechanics, Brown University, Providence, R. I. **In military service** 1927
BLODGETT, HOWARD B., Professor and Head, Dept. of Civil Engineering, South Dakota State College, Brookings, S. D. 1933
BLUMBERG, LEO, Associate Professor of Mechanical Engineering, University of Delaware, Newark, Del. 1922
BLUMENFELD, HARRY, Development Engineer, Sun Oil Co., Marcus Hook, Pa. 1941
BOARDMAN, H. S., President Emeritus, University of Maine, 172 Main Street, Orono, Me. (*President, 1930–31; Vice President, 1923–4; Member of Council, 1919–24; 1930–.*) 1903
BOARTS, ROBERT M., Professor and Head, Department of Chemical Engineering, University of Tennessee, Knoxville, Tenn. 1937
BOAST, WARREN B., Associate Professor of Electrical Engineering, Iowa State College, Ames, Iowa 1940
BOCK, ARTHUR E., Assistant Professor of Mechanical Engineering, Virginia Polytechnic Institute, Troy, N. Y. 1944
BOCK, LOUIS S., Instructor in Administrative Engineering, Cornell University, Ithaca, N. Y. **In military service** 1938
BOCKHORST, ROLAND W., Instructor in Applied Mathematics, Washington University, St. Louis, Mo. 1939
BODER, DAVID P., Professor of Psychology, Illinois Institute of Technology, Chicago, Ill. 1942

BOEHMER, HERBERT, Instructor in General Engineering, University of Washington, Seattle, Wash. 1943
BOELTER, LLEWELLYN M. K., Dean, College of Engineering, University of California, Los Angeles, Calif. 1931
BOGARD, BEN T., Assistant Professor of Mechanical Engineering, Louisiana Polytechnic Institute, Ruston, La. 1939
BOGEMA, MARVIN, Assistant Professor of Hydraulics, Cornell University, Ithaca, N. Y. 1943
BOGUSLAVSKY, BORIS W., Professor of Structural Engineering, University of Akron, Akron, Ohio 1943
BOHL, LEIGHTON T., Chairman, Division of Engineering, Professor of Civil Engineering, Brown University, Providence, R. I. 1941
BOHLIN, HOWARD G., Associate Professor of Mechanical Drawing, College of the City of New York, New York City 1935
BOLOTSKY, MAX, Assistant Metallurgist, Armor Plate Dept., Watertown Arsenal, Watertown, Mass. 1939
BOLTON, F. C., Executive Vice President, Dean of College, A. & M. College of Texas, College Station Texas. (*Member of Council, 1919–22; Vice President, 1937–38.*) 1910
BOLZ, HAROLD A., Associate Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1938
BOND, EUGENE W., Secretary-Treasurer, Bliss Electrical School, Takoma Park, Washington, D. C. 1942
BONE, ALEXANDER J., Assistant Professor of Highway Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1944
BONILLA, CHARLES F., Associate Professor and Acting Head, Dept. of Chemical Engineering, Johns Hopkins University, Baltimore, Md. ... 1944
BOOHER, EDWARD E., Vice President, McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. 1939
BOOMSLITER, G. P., Professor of Mechanics, West Virginia University, Morgantown, W. Va. (*Member of Council, 1934–7.*) 1912
BOON, LEONARD F., Assistant Professor of Civil Engineering, University of Minnesota, Minneapolis, Minn. 1922
BOONE, ENOCH M., Assistant Professor of Electrical Engineering, The Ohio State University, Columbus, Ohio 1943
BOOTH, ARCHIBALD A. K., Supervisor, Training Dept., Pratt and Whitney Aircraft, Storrs, Conn. 1943
BORG, SIDNEY F., Assistant Professor of Civil Engineering, University of Maryland, College Park, Md. 1944
BORGMAN, WILIALM M., Associate Professor of Mathematics, Wayne University, Detroit, Mich. 1939
BORGMANN, CARL W., Professor and Head, Dept. of Chemical Engineering, University of Colorado, Boulder, Colo. 1938
BORGQUIST, E. S., Professor and Head, Dept. of Civil Engineering, University of Arizona, Tuscon, Ariz. 1931
BORING, MAYNARD M., Technical Employment, General Electric Co., Schenectady, N. Y. (*Member of Council, 1935–8.*) 1922
BOSE, SURENDRA N., Chief Electrical Engineer, The Tata Iron and Steel Co., Ltd., Jamshedpur, via. Tatanagar, B. N. Rly., India. 1927
BOSS, WILLIAM, Professor Emeritus, Agricultural Engineering, University of Minnesota, St. Paul, Minn. 1925
BOSTON, ORLAN W., Professor of Metal Processing, University of Michigan, Ann Arbor, Mich. 1937
BOTERO LONDONO, JULIO, Director, Escuela Industrial, Bogota, Colombia, S. A. 1943

BOTTOMLEY, JOSEPH A., Assistant Professor of Mining and Metallurgy, University of Illinois, Urbana, Ill. 1943
BOUCHARD, HARRY, Professor of Geodesy and Surveying, University of Michigan, Ann Arbor, Mich. 1921
BOURGOIN, LOUIS, Director Adjunct, Ecole Polytechnique, Montreal, Canada 1942
BOWLER, EDMOND W., Professor and Head, Department of Civil Engineering, University of New Hampshire, Durham, N. H. 1923
BOWLES, EDWARD L., Professor of Electrical Communications, Massachusetts Institute of Technology, Cambridge, Mass. 1931
BOWMAN, DEAN O., Instructor in Economics, University of Michigan, Ann Arbor, Mich. 1942
BOWMAN, HARRY L., Professor and Head, Dept. of Civil Engineering, Drexel Institute, Philadelphia, Pa. 1922
BOWMAN, HENRY T., Assistant Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. 1929
BOWMAN, JAMES H., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1931
BOWMAN, JOHN G., Chancellor, University of Pittsburgh, Pittsburgh, Pa. 1923
BOWMAN, RICHARD S., Instructor in Humanities, The Cooper Union, New York City. **In military service** .. 1940
BOYAN, E. A., Chief, Planning and Production, Radiation Lab., M. I. T., Cambridge, Mass. 1943
BOYCE, EARNEST, Professor of Municipal and Sanitary Engineering, University of Michigan, Ann Arbor, Mich. 1924
BOYD, JAMES E., Emeritus Professor, The Ohio State University, Columbus, O. (*Member of Council, 1911–4.*) 1907
BOYNTON, JOHN E., Professor and Head, Dept. of Mechanical Engineering, Vanderbilt University, Nashville, Tenn. 1938
BOYNTON, PAUL W., Employment Supervisor, Socony Vacuum Oil Co., Inc., 26 Broadway, New York City. **In military service** 1937
BRACKETT, E. E., Professor and Chairman, Dept. of Agricultural Engineering, University of Nebraska, Lincoln, Nebr. 1923
BRACKETT, R. D., Associate Professor of English, University of Michigan, Ann Arbor, Mich. 1922
BRADLEY, JAMES A., Dean, In charge of graduate courses, Newark College of Engineering, Newark, N. J. 1931
BRADSHAW, GEORGE W., Associate Professor of Civil Engineering, University of Kansas, Lawrence, Kans. 1939
BRADT, WILBUR E., Professor and Head, Dept. of Chemistry and Chemical Engineering, University of Maine, Orono, Me. **In military service** 1937
BRADY, WILLIAM H., Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. 1944
BRAGG, FRANCIS C., Sales Manager, Nubin, U. S. Rubber Co., Bristol, R. I. 1940
BRAIDECH, MATHEW M., Professor of Industrial and Sanitary Chemistry, Case School of Applied Science, Cleveland, Ohio 1943
BRAINARD, BOYD B., Professor of Mechanical Engineering, Kansas State College, Manhattan, Kansas 1926
BRAIS, ROGER, Assistant Professor of Chemistry, Ecole Polytechnique, Montreal, Canada 1942
BRAMER, CHARLES R., Associate Professor of Civil Engineering, North Carolina State College, Raleigh, N. Car. 1935
BRANCH, WILLIAM H., In charge Contractor Section, Customer Div.; Central Station Divs., General Electric Co., Schenectady, N. Y. 1936

BRANDBERRY, JOHN B., Acting Dean, Professor of Mathematics and Engineering Mechanics, University of Toledo, Toledo, O. 1923

BRANDT, CARL G., Chairman, Dept. of English, University of Michigan, Ann Arbor, Mich. 1938

BRANIGAN, GEORGE F., Dean of Engineering, Bradley Polytechnic Institute, Peoria, Ill. 1929

BRATER, ERNEST F., Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1940

BRATTIN, CLAUD L., Professor and Head, Dept. Drawing and Design, Michigan State College, East Lansing, Mich. 1937

BRAUTLECHT, C. A., Professor of Chemistry and Chemical Engineering, University of Maine, Orono, Me. 1922

BRAY, JOHN L., Professor and Head, School of Chemical and Metallurgical Engineering, Purdue University, Lafayette, Ind. 1925

BRAZDA, LUMIR P., Instructor in Architecture and Engineering, Wilson City College, 5950 Talman Ave., Chicago, 29, Ill. 1943

BRECKENRIDGE, ROBERT W., Assistant Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1934

BREED, CHARLES B., Professor and Head, Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1904

BRENEMAN, JOHN W., Associate Professor of Engineering Mechanics, The Pennsylvania State College, State College, Pa. 1942

BRENKE, WILLIAM C., Professor of Mathematics, University of Nebraska, Lincoln, Nebr. 1929

BRENNECKE, CORNELIUS G., Associate Professor of Electrical Engineering, Lehigh University, Bethlehem, Pa. 1936

BRENTON, WALTER, Box 59, Grand Central Annex, New York City 1934

BREWINGTON, GAIL P., Professor of Physics, Lawrence Institute of Technology, Detroit, Mich. 1941

BRICK, ROBERT M., Assistant Professor of Metallurgy, Yale University, New Haven, Conn. 1943

BRICKLER, ALEXANDER J., Mechanical Engineer, C. & M. T. S., Ft. Monmouth Signal Labs., Ft. Monmouth, N. J. 1943

BRIDGMAN, DONALD S., Staff Assistant in Personnel Relations, American Tel. & Tel. Co., 195 Broadway, New York City 1939

BRIERLEY, JOHN R., Executive Alumni Secretary, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1936

BRIGGS, HERMON B., Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1937

BRIGHT, RICHARD, Assistant Professor of Chemical Engineering, North Carolina State College, Raleigh, N. C. 1942

BRIMHALL, GEORGE B., Assistant Division Engineer, Pan American Airways, 6018 Pinewood Road, Oakland, Calif. 1943

BRINKER, RUSSELL C., Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn. **In military service** .. 1931

BRINKER, WILLIAM E., Director of Engineering, Chemical Division, Corn Products Co., Argo, Ill. 1939

BROCK, GENE H., Assistant Professor of Engineering Drawing, A. & M. College of Texas, College Station, Texas 1942

BROCK, JOHN E., Instructor in Applied Mathematics, Washington University, St. Louis, Mo. 1943

BROMILOW, FRANK, Assistant Professor of Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. 1939

Bronwell, Arthur B., Associate Professor of Electrical Engineering, Northwestern Technological Institute, Evanston, Ill. 1937

Brooke, W. E., Professor and Head of Department of Mathematics and Mechanics, Dept. of Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. (*Member of Council, 1924–7.*).. 1902

Brooks, J. Ansel, Professor of Industrial Engineering, Newark College of Engineering, Retired, Madison, Conn. 1904

Brooks, Morgan, Professor Emeritus of Electrical Engineering, University of Illinois; 2311 Conn. Ave., Washington, D. C. 1899

Brothers, Leroy A., Assistant Professor of Civil Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937

Brown, Arthur S., Assistant Professor of Electrical Engineering, University of Arkansas, Fayetteville, Ark. 1930

Brown, Aubrey I., Professor and Acting Head, Dept. Heating and Ventilating, The Ohio State University, Columbus, O. 1914

Brown, Carl W., Assistant Professor of Electrical Engineering, University of Wyoming, Laramie, Wyo. 1939

Brown, Cleo A., Head, English and Coordination Department, General Motors Institute of Technology, Flint, Mich. 1931

Brown, Edward C., Assistant Professor of Mathematics, Worcester Polytechnic Institute, Worcester, Mass. 1922

Brown, Edward S., Assistant Professor of Civil Engineering, Dartmouth College, Hanover, N. H. 1937

Brown, Frank N. M., Associate Professor and Head, Dept. Aeronautical Engineering, University of Notre Dame, Notre Dame, Ind. 1939

Brown, Frederick L., Professor of Physics, University of Virginia, University, Va. 1926

Brown, F. L., Professor of Applied Mechanics, University of Kansas, Lawrence, Kans. 1915

Brown, George G., Professor and Chairman, Dept. Chem. and Met. Eng., University of Michigan, Ann Arbor, Mich. 1939

Brown, Hugh A., Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1928

Brown, Hal C., Associate Professor of English, Georgia School of Technology, Atlanta, Ga. 1944

Brown, Jesse C., Assistant Professor of Industrial Management, Georgia School of Technology, Atlanta, Ga. 1944

Brown, James R., Supervisor of Education, General Electric Technical Night School, Erie, Pa. 1943

Brown, Ralph E., Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. 1924

Brown, Rex L., Associate in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1943

Brown, Robert Q., Associate Professor of General Engineering, University of Washington, Seattle, Wash. 1941

Brown, R. T., Assistant Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn. 1937

Brown, Robert V., Assistant Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio 1943

Brown, T. C., Assistant Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1937

Brown, Walter F., Professor of Electrical Engineering, University of Toledo, Toledo, Ohio 1941

BROWNE, WM. HAND, JR., Professor of Electrical Engineering, North Carolina College of A. & E., State College Station, Raleigh, N. C. (*Member of Council, 1916–9.*) 1899
BROZEN, YALE, Assistant Professor of Economics, Illinois Institute of Technology, Chicago, Ill. 1942
BRUBAKER, WM. F., Associate Professor of Engineering Drawing and Machine Design, University of Colorado, Boulder, Colo. 1924
BRUHN, ELMER F., Professor and Head of Aeronautical Engineering, Purdue University, Lafayette, Ind. 1943
BRUMFIELD, RAY C., Associate Professor of Civil Engineering, Cooper Union, New York City 1929
BRUNER, WARREN D., Coordinator of Cadette Training, Curtiss-Wright Corp., 1100 Main St., Buffalo, N. Y. 1944
BRUST, ALVIN W., Associate Professor of Civil Engineering, Washington University, St. Louis, Mo. 1941
BRYAN, COLGAN H., Assistant Professor, Acting Head, Dept. of Aeronautical Engineering, University of Alabama, University, Ala. 1943
BRYAN, NOAH R., Professor of Mathematics, University of Maine, Orono, Me. 1944
BRYANS, ANDREW E., Assistant Professor of Engineering Drawing, Franklin and Marshall College, Lancaster, Pa. 1944
BRYANS, W. R., Assistant Dean, Professor of Mechanics, New York University, New York, N. Y. 1908
BRYANT, J. M., Professor and Head, Dept. of Electrical Engineering, University of Minnesota, Minneapolis, Minn. (*Member of Council, 1927–30.*) 1910
BUBB, FRANK W., Professor of Applied Mathematics, Washington University, St. Louis, Mo. 1938
BUCHAN, ALEXANDER M., Assistant Professor of English, Washington University, St. Louis, Mo. 1939
BUCHANAN, JESSE E., Dean, College of Engineering, and Director, Eng. Experiment Sta., University of Idaho, Moscow, Idaho. **In military service** 1927
BUCHANAN, ROY O., Associate Professor of Electrical Engineering, University of Vermont, Burlington, Vt. 1922
BUCHER, PAUL, Professor of Mechanical Engineering, The Ohio State University, Columbus, Ohio 1920
BUCK, A. M., Principal Transportation Analyst, Office of Defense Transportation, Room 3406, I.C.C. Bldg., Washington, D. C. 1910
BUCK, CARSON P., Assistant Professor of Engineering Drawing, University of Notre Dame, Notre Dame, Ind. 1939
BUCKINGHAM, EARLE, Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1932
BUCKY, P. B., Associate Professor of Mining, Columbia University, New York City 1940
BUDENHOLZER, ROLAND A., Assistant Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. 1941
BUDGE, WILLIAM E., Professor of Mining Engineering, University of North Dakota, Grand Forks, N. D. 1938
BUECHE, H. S., Professor of Electrical Engineering, Villanova College, Villanova, Pa. 1932
BUERER, WAYNE W., Assistant Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1939
BULLARD, JAMES A., Professor and Head, Dept. of Mechanics and Mathematics, University of Vermont, Burlington, Vt. 1927

BULLEN, CHARLES V., Professor and Head, Department of Electrical Engineering, Texas Technological College, Lubbock, Texas 1934
BULLINGER, CLARENCE E., Professor and Head, Dept. of Industrial Engineering, The Pennsylvania State College, State College, Pa. 1925
BULLOCK, ROBERT C., Associate Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1937
BUNKER, ALBION H., Assistant Professor of Engineering Drawing and Descriptive Geometry, Virginia Polytechnic Institute, Blacksburg, Va. 1943
BUNKER, JOHN W. M., Dean, Graduate School, Massachusetts Institute of Technology, Cambridge, Mass. 1940
BURDELL, EDWIN S., Director, Cooper Union, New York City 1937
BURDEN, HARRY P., Dean, Engineering School, and Professor of Sanitary Engineering, Tufts College, Medford, Mass. 1921
BURDETT, ROY W., Professor of Engineering, North Texas Agricultural College, Arlington, Texas 1943
BUREAU, E. A., Professor and Head, Dept. of Electrical Engineering, University of Kentucky, Lexington, Ky. 1923
BURG, WALTER V., Associate Professor and Acting Head, Dept. of Physics, University of Toledo, Toledo, Ohio 1944
BURINGTON, RICHARD S., Associate Professor of Mathematics, Case School of Applied Science, Cleveland, Ohio. **In military service** 1934
BURKLAND, CARL E., Professor of English, University of Michigan, Ann Arbor, Mich. 1940
BURLEY, JOHN W., Head, Machine Dept., Pratt Institute, Brooklyn, N. Y. 1926
BURMISTER, DONALD M., Assistant Profesor of Civil Engineering, Columbia University, New York City 1935
BURR, ARTHUR H., Assistant Professor of Mechanical Engineering, University of Missouri, Columbia, Mo. (Research Engineer, N.D.R.C., Northwestern University, Evanston, Ill.) 1941
BURROUGHS, FREDERICK D., Educational Director, Utilities Engineering Institute, 1314 Belden Ave., Chicago, Ill. 1943
BURSLEY, JOSEPH A., Professor of Mechanical Engineering, Dean of Students, University of Michigan, Ann Arbor, Mich. 1910
BUSH, B. H., Dean of Engineering, Fenn College, Cleveland, Ohio. **In military service** 1935
BUSH, GEORGE F., Assistant Professor of Graphics, Princeton University, Princeton, N. J. 1944
BUSH, VANNEVAR, President, Carnegie Institution of Washington, D. C... 1923
BUTLER, G. M., Dean, College of Engineering, Director, Arizona Bureau of Mines, University of Arizona, Tucson, Ariz. (*Member of Council, 1924–7.*) 1916
BUTLER, HOWARD W., New Britain Machine Co., New Britain, Conn. 1943
BUTLER, JOE B., Professor of Civil Engineering, Missouri School of Mines and Metallurgy, Rolla, Mo. 1922
BUTLER, JOHN H., 125 So. Highland Ave., Winchester, Ky. 1935
BUTLER, N. RICHARD, Acting Head, Dept. of Mechanical Engineering, Acting Director, Bureau of Industrial Research, Norwich University, Northfield, Vt. 1944
BUTTERFIELD, ARTHUR D., Professor Emeritus of Mathematics and Geodesy, University of Vermont, Burlington, Vt. 1908
BUTTERFIELD, THOMAS E., Professor Emeritus, 1736 W. Union Bldg., Bethlehem, Pa. 1920
BUTTRAM, HENRY J., Instructor in Electrical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1943

BUTTS, ALLISON, Professor of Electrometallurgy, Lehigh University, Bethlehem, Pa. 1934

BYERLAY, HENRY L., Manager, Circuit Div., Sylvania Elec. Prod., Inc., Salem, Mass. 1943

CADE, C. MARSHALL, Professor of Civil Engineering, Michigan State College, East Lansing, Mich. **In military service** 1937

CADY, LOUIS C., Professor and Head, Dept. of Chemistry and Chemical Engineering, Acting Dean, University of Idaho, Moscow, Ida. 1931

CAGE, JOHN M., Electrical Engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis. 1942

CALDWELL, CHESTER W., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1943

CALDWELL, FRANK C., Professor Emeritus, The Ohio State University, Columbus, O. (*Member of Council, 1905–8.*) 1897

CALDWELL, ROBERT G., Dean of Humanities, Massachusetts Institute of Technology, Cambridge, Mass. 1944

CALHOON, FLOYD N., Assistant Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1940

CALLAGHAN, JOSEPH C., Assistant Professor of English and Speech, Lehigh University, Bethlehem, Pa. 1936

CALLEN, ALFRED C., Dean, College of Engineering, Professor and Head, Department of Mining Engineering, Lehigh University, Bethlehem, Pa. (*Member of Council, 1941–4.*) 1926

CALVERT, JOHN F., Professor and Chairman, Dept. of Electrical Engineering, Northwestern Technological Institute, Evanston, Ill. 1937

CAMERON, HUGH S., Associate Professor of Mechanical Engineering, Rice Institute, Houston 5, Texas 1928

CAMP, CECIL S., Associate Professor of Hydraulic Engineering, University of Tennessee, Knoxville, Tenn. 1936

CAMP, FREDERIC E., Dean of the College, Stevens Institute of Technology, Hoboken, N. J. 1943

CAMPBELL, DONALD P., Instructor in Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943

CAMPBELL, GEORGE W., Assistant State Supervisor, ESMWT, University of Alabama, University, Ala. 1943

CAMPBELL, JESSE M., Assistant Professor of Mechanical Engineering, Michigan State College, East Lansing, Mich. 1931

CAMPBELL, JOHN S., Instructor in Electrical Engineering, California Institute of Technology, Pasadena, Calif. 1942

CAMPBELL, LAURA S., Acting Director, Evening Diploma School, Drexel Institute of Technology, Philadelphia, Pa. 1944

CAMPBELL, ROBERT M., Professor of Ceramic Technology, New York State College of Ceramics at Alfred University, Alfred, N. Y. 1937

CAMPBELL, WM. B., Editor, Technical Publications, Cochrane Corp., 6848 No. 7th St., Philadelphia 26, Pa. 1939

CANAVACIOL, FRANK E., Associate Professor of Electrical Communications, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1928

CANDEE, F. W., Assistant Professor of Mechanical Engineering, Washington State College, Pullman, Wash. 1924

CANFIELD, DONALD T., Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1925

CANNON, JOSEPH H., Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1940

CANTERBURY, SAMUEL L., Head of Engineering, Kilgore College, Kilgore, Texas 1943

Caparo, Jose A., Professor of Electrical Engineering, University of Notre Name, Notre Dame, Ind. 1939
Cardin, C. J., Professor and Head, Dept. of General Engineering, North Central College, Naperville, Ill. 1937
Cardoso, Antonio C., Assistant Professor of Electrical Engineering, University of S. Paulo, S. Paulo, Brasil, S. A. 1935
Carey, Clifton O., Associate Professor of Geodesy and Surveying, University of Michigan, Ann Arbor, Mich. 1941
Carey, Robert H., Mechanical Engineer, Bakelite Corp., Bound Brook, N. J. 1938
Carlisle, Duane F., Instructor in Physics, University of New Hampshire, Durham, N. H. 1943
Carlson, De Von M., Instructor in Engineering Drawing, University of Colorado, Boulder, Colo. 1944
Carlson, Walter W., Professor and Head, Dept. of Shop Practice, Kansas State College, Manhattan, Kans. 1912
Carlton, Ernest W., Professor of Structural Engineering, Missouri School of Mines, Rolla, Mo. 1937
Carmichael, Colin, Associate Editor, Machine Design, Penton Pub. Co., Cleveland, Ohio 1934
Carpenter, Arthur Howe, Associate Professor of Metallurgy, Illinois Institute of Technology, Chicago, Ill. 1935
Carpenter, Edward L., Assistant Professor of Mechanical Engineering Rhode Island State College, Kingston, R. I. 1922
Carpenter, Jay A., Director, Mackay School of Mines, University of Nevada, Reno, Nev. 1934
Carpenter, Otto, Supervisor of College Relations, Western Electric Co., 195 Broadway, New York City 1936
Carpenter, Samuel T., Associate Professor of Civil Engineering, Swarthmore College, Swarthmore, Pa. 1936
Carr, Arthur R., Dean, College of Engineering, Wayne University, Detroit, Mich. 1927
Carr, Clifford C., Supervisor, Head, Dept. of Electrical Engineering, Pratt Institute, Brooklyn, N. Y. 1926
Carr, Frank J., Water Division, A. P. O. 997, c/o P. M., Seattle, Wash. 1943
Carrizosa Valenzuela, Julio, Rector, Universidad Nacional de Colombia, Bogota, Colombia, S. A. 1943
Carruthers, John L., Professor of Ceramic Engineering, The Ohio State University, Columbus, Ohio 1929
Carson, Gordon B., Associate Professor of Industrial Engineering, Case School of Applied Science, Cleveland, Ohio 1934
Carson, William H., Dean, College of Engineering, University of Oklahoma, Norman, Okla. 1942
Carter, Clifton C., Professor of Natural and Experimental Philosophy, U. S. Military Academy, West Point, N. Y. **In military service** .. 1928
Carter, C. W., Instructor in Drawing, Clemson College, Clemson, S. C. .. 1943
Carter, Harold S., Professor of Civil Engineering, Utah Agricultural College, Logan, Utah 1924
Cartier, Leonard, Assistant Professor of Hydraulics, Ecole Polytechnique, Montreal, Canada 1942
Cartland, Fred W., Assistant Professor of Electrical Engineering, Michigan College of M. & T., Houghton, Mich. 1938
Carvin, Frank D.. Professor and Head, Dept. of Mechanical Engineering, Newark College of Engineering, Newark, N. J. 1925

CASAGRANDE, ARTHUR, Associate Professor of Civil Engineering, Harvard University, Cambridge, Mass. 1935
CASBERG, CARL H., Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1933
CASE, ALLANDO A., Associate in Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1932
CASE, GEO. W., Dean, College of Technology, Director, Engineering Experiment Station, University of New Hampshire, Durham, N. H. (Director, E. S. M. W. T., U. S. Office of Education, Washington, D. C.) (*Member of Council, 1934–7; Vice President, 1938–9.*) 1914
CASSEL, ELLWOOD B., Assistant Professor of Engineering Drawing, The Pennsylvania State College, State College, Pa. 1937
CASSELL, WALLACE L., Professor of Electrical Engineering, Iowa State College, Ames, Iowa 1939
CASTLEMAN, FRANCIS L., JR., Professor and Head, Dept. of Civil Engineering, University of Connecticut, Storrs, Conn. 1938
CASTLEMAN, JOHN R., Associate Professor of Engineering Drawing, Virginia Polytechnic Institute, Blacksburg, Va. 1930
CATHER, CARL H., Associate Professor and Acting Head, Dept. of Mechanics, West Virginia University, Morgantown, W. Va. 1936
CATHER, HAROLD M., Associate Professor of Power Engineering, West Virginia University, Morgantown, W. Va. 1937
CATON, JOHN J., Director, Chrysler Institute of Engineering, Detroit, Mich. 1942
CAUGHEY, R. A., Professor of Structural Engineering, Iowa State College, Ames, Iowa 1911
CAVERLEY, L. C., Associate Professor of Electrical Engineering, University of Minnesota, Minneapolis, Minn. 1927
CAYWOOD, THOMAS G., Associate Professor of Mechanical Engineering, State University of Iowa, Iowa City, Iowa 1936
CEAGLSKE, NORMAN H., Assistant Professor of Chemical Engineering, Washington University, St. Louis, Mo. 1944
CEJKA, JOSEPH B., Assistant Professor of Mechanical Engineering, Rutgers University, New Brunswick, N. J. 1938
CELL, JOHN W., Associate Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1936
CERDA, HERMAN E., Director, Center of Electrical Engineering, Polytechnical Institute of the Catholic University of Chile, Santiago, Chile, S. A. 1943
CHADERTON, JULIAN C., Office Engineer, Herlihy Mid-Continent Co., 4700 No. Winchester Ave., Chicago 40, Ill. 1942
CHAMBERLAIN, JOSEPH B., Instructor in Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1937
CHAMBERLAIN, JOS. J., Associate Professor of Civil Engineering, University of Dayton, Dayton, Ohio 1940
CHAMBERLAIN, MARGUERITE, Eastman Librarian, Massachusetts Institute of Technology, Cambridge, Mass. 1941
CHAMBERLIN, STEPHEN J., Associate Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1935
CHAMBERS, ALVIN L., Associate Professor of Testing Materials, University of Kentucky, Lexington, Ky. 1938
CHAMBERS, CARL C., Associate Professor of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. 1943
CHAMBERS, SHERMAN D., Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. 1921

CHANDLER, E. F., Professor of Civil Engineering and Dean Emeritus, College of Engineering, University of North Dakota, University, N. D. 1907

CHAPMAN, ROBERT G., Associate Professor and Head, Dept. of Mechanical Engineering, University of Vermont, Burlington, Vt. 1939

CHARP, SOLOMON, Instructor in Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. 1943

CHASE, CARL T., Associate Professor of Electrical Communications, Massachusetts Institute of Technology, Cambridge, Mass. 1944

CHASE, CHARLES H., Professor of Steam Engineering, Emeritus, Tufts College, Stoneham, Mass. 1935

CHEATHAM, JAMES C., Instructor in Mechanical Engineering, North Carolina State College, Raleigh, N. C. **In military service** 1941

CHEEK, FRANK J., JR., Professor of Sanitary Engineering, University of Kentucky, Lexington, Ky. 1924

CHERRY, CARLTON E., Instructor in Engineering and Mathematics, Marin Junior College, Kentfield, Calif. 1931

CHERRY, FLOYD H., Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1930

CHESIRE, ESTHER E., Assistant Librarian, Illinois Institute of Technology, Chicago, Ill. 1944

CHESTERMAN, FRANCIS J., Vice President, Bell Telephone Co. of Pa., Philadelphia, Pa. 1936

CHILDS, HERBERT R., Assistant Professor of Physics, University of Rochester, Rochester, N. Y. 1944

CHILLMAN, EDWARD F., Emeritus Professor of Drawing, Rensselaer Polytechnic Institute, Troy, N. Y. 1920

CHILTON, THOMAS H., Director, Technical Div., Engineering Dept., E. I. duPont de Nemours & Co., Wilmington, Del. 1939

CHRISTENSEN, N. A., Dean of Engineering, Colorado State College, Ft. Collins, Colo. 1938

CHRISTENSEN, THEODORE J., Director, Daytime YMCA College, Dayton, Ohio 1943

CHRISTIE, A. G., Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md. 1923

CHURBUCK, LEWIS M., President, The Aeronautical Universities, Inc., 641 So. Elm St., Hinsdall, Ill. 1943

CHURCH, A. H., Associate Professor of Machine Design, New York University, New York City 1940

CHURCH, EDWIN F., JR., Professor of Mechanical Engineering, The Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1910

CHURCH, JAMES M., Assistant Professor of Chemical Engineering, Columbia University, New York City 1941

CIRCÉ, ARMAND, Dean of Engineering, Ecole Polytechnique, Montreal, Canada 1930

CLARK, ADRIAN N., Technical Editing, D. Van Nostrand Co., 250 Fourth Ave., New York City 1941

CLARK, DAVIS S., Assistant Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1932

CLARK, DONALD S., Assistant Professor of Mechanical Engineering, California Institute of Technology, Pasadena, Calif. 1942

CLARK, EDGAR C., Associate Professor of Mechanics, The Ohio State University, Columbus, Ohio 1928

CLARK, EDWIN E., Professor of Electrical Engineering, South Dakota School of Mines, Rapid City, S. D. 1922

CLARK, GEORGE W., Associate Professor of Civil Engineering, Ohio University, Athens, Ohio 1938
CLARK, JAMES C., Professor of Electrical Engineering, University of Arizona, Tucson, Ariz. 1912
CLARK, LEROY W., Professor and Head, Dept. of Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y. 1922
CLARK, ROY E., Associate Professor of Heat Power Engineering, Cornell University, Ithaca, N. Y. 1937
CLARKE, CLARENCE L., Dean of Arts and Science, Illinois Institute of Technology, Chicago, Ill. 1939
CLARKE, ELWYN L., Professor and Head, Dept. of Civil Engineering, Clemson College, Clemson College, S. C. 1921
CLARKE, JAMES G., Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. 1943
CLAYTON, CHARLES Y., Professor of Metallurgical Engineering, Missouri School of Mines, Rolla, Mo. 1944
CLAYTON, WALTER C., Coordinator, Engineering Education, Lockheed Aircraft Corp., Burbank, Calif. 1941
CLEARY, STEPHEN F., Associate Professor of Engineering Drawing, Cornell University, Ithaca, N. Y. 1932
CLEETON, GLEN U., Director, Div. Humanistic and Social Studies, Carnegie Institute of Technology, Pittsburgh, Pa. 1944
CLEGHORN, M. P., Professor of Mechanical Engineering, Iowa State College, Ames, Ia. 1910
CLELAND, SAMUEL M., Instructor in Engineering Drawing, A. & M. College of Texas, College Station, Texas 1942
CLEMENT, WILLIAM B., Apt. 9, 650 Blvd. N.E., Atlanta, Ga. 1940
CLEMENTS, S. EUGENE, Assistant Professor of Electrical Engineering, University of Kansas, Lawrence, Kansas. **In military service** 1940
CLEVELAND, LAURENCE F., Associate Professor of Electrical Engineering, Northeastern University, Boston, Mass. 1930
CLICKENER, CORWIN K., Chief Industrial Engineer, Asphalt Products, Johns Manville Products Corp., 15 N. Lewis Ave., Waukegan, Ill. .. 1939
CLIFFORD, ALBERT C., Engineer, Personnel Dept., Western Electric Co., Kearny, N. J. 1944
CLOKE, PAUL, Dean, College of Technology, University of Maine, Orono, Me. (*Vice President, 1932–33; Member of Council, 1928–31.*) 1919
CLOSE, GEORGE D., Technical Personnel, Goodyear Tire and Rubber Co., Akron, Ohio 1944
CLOUD, WILBUR F., Professor of Petroleum Engineering, University of Oklahoma, Norman, Okla. 1938
CLOUSE, JOHN H., Test Engineer, Lion Mfg. Corp., 5643 Blackstone Ave., Chicago, Ill. 1927
CLOWER, JAMES I., Professor of Machine Design, Virginia Polytechnic Institute, Blacksburg, Va. **In military service.** (War Dept., Wash., D. C.) .. 1937
CLUVERIUS, WAT T., President, Worcester Polytechnic Institute, Worcester, Mass. 1943
CLYDE, GEORGE D., Dean, School of Engineering, Utah State Agricultural College, Logan, Utah 1937
COAN, JOHN M., Assistant Professor of Aeronautical Engineering, Iowa State College, Ames, Iowa 1944
COATES, JESSE, Associate Professor of Chemical Engineering, Louisiana State University, University, La. 1939

COBB, WILLIAM C., College Editor, Houghton Mifflin Co., 2 Park St., Boston, Mass. 1944
COBINE, JAMES D., Assistant Professor of Electrical Engineering, Harvard University, Cambridge, Mass. 1938
COBURN, THEODORE, Western Representative, John Wiley and Sons, Inc., 440 Fourth Avenue, New York City 1925
COCKRELL, WAYNE L., Assistant Professor of Mechanical Engineering, Michigan State College, East Lansing, Mich. **In military service** 1938
CODDINGTON, E. F., Emeritus Professor of Geodetic Engineering, The Ohio State University, Columbus, Ohio. 1911
CODWISE, HENRY R., Professor of Railroad Engineering and Surveying, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1914
COFFINBERRY, ARTHUR S., Research Metallurgist, Tube Turns, Inc., Louisville 1, Ky. 1941
COLBERT, JULES P., Associate Professor of Engineering Mechanics, Freshman Advisor, University of Nebraska, Lincoln, Nebr. 1935
COLBERT, THOMAS P., Instructor, Service School, Woodward Governor Co., Rockford, Ill. 1943
COLBURN, ALLAN P., Professor of Chemical Engineering, University of Delaware, Newark, Del. 1938
COLE, R. W., Assistant Mechanical Engineer, U. S. Naval Air Station, Quonset Point, R. I. 1939
COLES, HENRY L., Professor and Head, Dept. of Chemical Engineering and Chemistry, Michigan College of M. & T., Houghton, Mich. 1943
COLLARD, ARTHUR A., Assistant Professor of Mechanical Engineering, Pratt Institute, Brooklyn, N. Y. 1938
COLLIER, IRA L., Assistant Professor of Civil Engineering, University of Washington, Seattle, Wash. 1924
COLLINS, BASIL K., Instructor in Industrial Engineering and Shops, Alabama Polytechnic Institute, Auburn, Ala. **In military service** 1935
COLLINS, GEORGE B., Associate Professor of Physics, University of Notre Dame, Notre Dame, Ind. 1939
COLLINS, W. LEIGHTON, Assistant Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. **In military service** 1932
COLLYER, NORMAN, Assistant Secretary, Paramount Pictures, Inc., Paramount Building, Times Square, New York City 1919
COLVERT, WILLIAM W., Associate Professor of Physics, Illinois Institute of Technology, Chicago, Ill. 1935
COLVIN, CHARLES H., Director, School of Aeronautics, Coordinator of Research, New York University, New York City 1941
COLVIN, FRED H., Consultant, Navy Bureau of Aeronautics, 2000 F St., N.W., Washington, D. C. 1942
COMI, PETER J., Instructor in Surveying and Drawing, Brown University, Providence, R. I. 1944
COMPTON, HORACE B., Assistant Professor of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. **In military service** 1934
COMPTON, KARL T., President, Massachusetts Institute of Technology, Cambridge, Mass. (*Member of Council, 1933–36, 1937–; Vice President, 1937–38; President, 1938–39.*) 1929
COMSTOCK, E. H., Professor Emeritus, Dyscom Farm, University of Minnesota, Monticello, Minn. 1938
CONDIT, KENNETH H., Dean, School of Engineering, Professor of Mechanical Engineering, Princeton University, Princeton, N. J. (*Member of Council, 1939–42.*) 1937

CONDON, EDWARD U., Associate Director of Research, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1941

CONLEY, HUGH G., Instructor in Civil Engineering, University of Southern California, Los Angeles, Calif. **In military service** 1939

CONLEY, WILLIAM J., Consulting Engineer, Lincoln Electric Co., Cleveland 1, Ohio 1929

CONLON, EMERSON W., Associate Professor of Aeronautical Engineering, University of Michigan, Ann Arbor, Mich. **In military service** ... 1940

CONNER, N. WHITE, Associate Professor of Engineering Mechanics, North Carolina State College, Raleigh, N. C. 1931

CONNOLLY, JOSEPH P., President and Professor of Geology, South Dakota School of Mines, Rapid City, S. D. 1937

CONOVER, LAWRENCE J., 3 Bancker St., Albany, N. Y. 1942

CONRAD, ALBERT G., Chairman, Dept. of Electrical Engineering, Yale University, New Haven, Conn. 1929

CONRAD, FRANK H., Associate Professor of Chemical Engineering, Missouri School of Mines, Rolla, Mo. 1938

CONRAD, L. E., Professor and Head, Dept. of Civil Engineering, Kansas State College, Manhattan, Kansas. (*Vice President, 1940–1; Member of Council, 1931–4.*) 1908

CONROE, IRWIN A., Assistant Commissioner of Education, State Dept., of Education, Albany, N. Y. 1942

CONSTANT, F. H., Professor of Civil Engineering, Emeritus, Princeton University, Princeton, N. J. (*Vice President, 1915–6; Member of Council, 1909–12.*) 1896

CONVERSE, FRANK P., President Engineers Local No. 18, Intl. Union of Operating Engineers, 216 High St., Cleveland, Ohio 1943

COOGAN, CHARLES H., JR., Assistant Professor of Mechanical Engineering, University of Connecticut, Storrs, Conn. 1931

COOK, A. L., Retired; Worcester 2, Mass. 1913

COOK, RUDYARD M., Lecturer in Civil Engineering, Northwestern University, Evanston, Ill. 1941

COOKE, HENRY C., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. 1940

COOKE, NELSON M., Executive Officer, Radio Material School, Naval Research Laboratory, Washington, 20, D. C. **In military service** . 1942

COOKE, S. P., Lecturer in Electronics, Harvard University, Cambridge, Mass. 1939

COOLBAUGH, MELVILLE F., President, Colorado School of Mines, Golden, Colo. 1925

COOLEY, ALBERT M., Associate Professor of Chemical Engineering, University of North Dakota, Grand Forks, N. D. 1935

COOLEY, HENRY B., Assistant Professor of Economics and Business Administration, West Virginia University, Morgantown, W. Va. (173 Slocum Ave., Englewood, N. J.) 1938

COOLEY, M. E., Dean Emeritus, University of Michigan, Ann Arbor, Mich. (*President, 1920–1; Vice President, 1908–9; Member of Council, 1893–4; 1907–10; 1920–; Member, Board of Investigation and Coordinations, 1922–8.*) 1893

COOLIDGE, WARREN A., Professor of Civil Engineering, Vanderbilt University, St. Louis, Mo. 1944

COONLEY, LEWIS S., Head, Dept. of Chemical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1943

COONRADT, ARTHUR C., Professor and Chairman, Dept. of Mechanical Engineering, New York University, New York City 1932

COONS, KENNETH W., Professor and Head, Dept. of Chemical Engineering, University of Alabama, Tuscaloosa, Ala. 1939
COOPER, ALBERT H., Associate Professor of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. **In military service** .. 1936
COOPER, CHARLES D., Associate Professor of Engineering Drawing, The Ohio State University, Columbus, Ohio 1942
COOPER, GUY, Instructor in Industrial Engineering, The Ohio State University, Columbus, Ohio 1943
COOPER, LEMUEL B., Assistant Professor of Mechanical Engineering, University of Washington, Seattle, Wash. 1943
COOPER, LINTON L., Professor and Head, Dept. of Mechanical Drawing, Louisiana State University, Baton Rouge, La. 1934
COOPEY, MARTIN P., Assistant Professor of Civil Engineering, Oregon State College, Corvallis, Ore. 1943
COOVER, MERVIN S., Professor and Head, Department of Electrical Engineering, Iowa State College, Ames, Iowa 1923
COPE, RALPH L., Assistant Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1939
COPE, STANLEY R., President, Acme School of Die Design Engineering, South Bend, Ind. 1943
COPE, WILLIAM J., Professor and Head, Dept. of Mechanical Engineering, University of Utah, Salt Lake City, Utah 1937
COPELAND, PAUL L., Professor of Physics, Illinois Institute of Technology, Chicago, Ill. 1941
COPELAND, ROBERT M., Colonel, Corps of Engineers, Imperial Dam Engineer Station, Yuma, Ariz. **In military service** 1935
COPPERSMITH, C. W., Associate Professor and Head, Dept. of Engineering Drawing, Case School of Applied Science, Cleveland, O. 1915
CORCORAN, GEORGE F., Professor and Chairman, Dept. of Electrical Engineering, University of Maryland, College Park, Md. 1926
CORNELL, W. R., Professor of Mechanics of Engineering, Cornell University, Ithaca, N. Y. 1910
CORY, MERTON M., Professor of Electrical Engineering, Michigan State College, East Lansing, Mich. 1937
COSTA, JOHN J., Professor of Civil Engineering, Manhattan College, New York City 1927
COTHERN, LELAND I., Professor of Mining Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1939
COTTINGHAM, WILLARD S., Associate Professor of Structural Engineering, University of Wisconsin, Madison, Wis. 1937
COULL, JAMES, Professor and Head, Dept. of Chemical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1939
COVAN, JACK P., Foundry Engineer, Spo Inc., 10603 Canfield Ave., Cleveland 5, Ohio 1939
COVENTRY, NEIL M., Head of Engineering, Multnomah College, YMCA, 831 S.W. 6th Ave., Portland, Ore. 1943
COVER, GERALD M., Associate Professor of Metallurgy, Case School of Applied Science, Cleveland, Ohio 1939
COWGILL, ALLEN P., Assistant Professor of Applied Mathematics, Syracuse University, Syracuse, N. Y. 1941
COWIE, ALEXANDER, Research Engineer, Foote Bros. Gear Corp., 3017 E. 78th St., Chicago, Ill. 1933
COWLES, W. H. H., Head, Department of Mathematics, Pratt Institute, Brooklyn, N. Y. 1929

COX, GLEN N., Professor and Head, Dept. of Hydraulics, Louisiana State University, University, La. 1935
CRABTREE, FREDERICK H., Assistant Professor of Civil Engineering, Tufts College, Medford, Mass. 1934
CRABTREE, KENNETH G., Assistant Professor of Electrical Engineering, University of Maine, Orono, Me. 1942
CRAFT, BENJAMIN C., Professor and Head, Dept. of Petroleum Engineering, Louisiana State University, University, La. 1935
CRAIG, HOMER V., Professor of Applied Mathematics and Astronomy, University of Texas, Austin, Texas 1942
CRAIN, HARRY M., Director of Publications and Summer School, Colorado School of Mines, Golden, Colo. 1943
CRAMER, ERNEST S., Instructor in Engineering Drawing, Syracuse University, Syracuse, N. Y. 1943
CRANE, EDWARD M., President, D. Van Nostrand Co., 250 Fourth Ave., New York, N. Y. 1944
CRANE, WILLIAM G., Chairman, Dept. of English, College of the City of New York, New York City 1940
CRATER, DAVID H., Instructor in Civil Engineering, Princeton University, Princeton, N. J. 1943
CRAWFORD, CHARLES W., Professor and Head, Department of Mechanical Engineering, A. & M. College of Texas, College Station, Tex. 1923
CRAWFORD, IVAN C., Dean, School of Engineering, Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. (*Member of Council, 1929–32; Vice President, 1936–37.*) 1913
CRAWFORD, I. C., JR., Instructor in Civil Engineering, Rhode Island State College, Kingston, R. I. **In military service** 1939
CRAWFORD, T. STEPHEN, Professor and Head, Dept. of Chemical Engineering, Rhode Island State College, Kingston, R. I. 1936
CRAWFORD, W. W., Associate Professor of Civil Engineering, Kansas State College, Manhattan, Kans. 1926
CREAGER, PAUL S., Associate Professor of Electrical Engineering, Rutgers University, New Brunswick, N. J. 1923
CREAMER, WALTER J., Professor of Communication Engineering, University of Maine, Orono, Me. 1922
CREDLE, ALEXANDER B., Associate Professor of Electrical Engineering, Cornell University, Ithaca, N. Y. 1935
CREEK, HERBERT L., Professor of English, Purdue University, Lafayette, Ind. 1922
CREESE, JAMES, Vice President, Stevens Institute of Technology, Hoboken, N. J. 1934
CREESE, MYRON, Professor of Electrical Engineering, University of Maryland, College Park, Md. 1941
CROFOOT, GEORGE E., Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. 1919
CROFT, HUBER O., Professor and Head, Mechanical Engineering Department, State University of Iowa, Iowa City, Iowa. (*Member of Council, 1944–47.*) 1931
CROMER, ORVILLE C., Associate Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1940
CROMWELL, PAUL C., Associate Professor of Electrical Engineering, New York University, New York City 1935
CROSBY, LEMUEL S., General Personnel Supervisor, Long Lines Dept., American Telephone and Telegraph Co., 32 6th Ave., New York, N. Y. 1929

CROSLAND, DOROTHY M., Librarian, Georgia School of Technology, Atlanta, Ga. 1944

CROSS, HARDY, Professor and Chairman, Dept. of Civil Engineering, Yale University, New Haven, Conn. 1912

CROSSLEY, F. R. ERSKINE, 21 Bluff Ave., West Haven, Conn. 1943

CROSSMAN, RALPH S., Associate in General Engineering Drawing, University of Illinois, Urbana, Ill. 1919

CROTHERS, H. M., Dean, Division of Engineering, Professor of Electrical Engineering, South Dakota State College, Brookings, S. D. (*Second Vice President, 1944–5.*) 1923

CROUCH, JOEL E., Assistant Professor of Industrial Engineering, Pennsylvania State College, State College, Pa. 1940

CROUSE, WILLIAM H., Service Engineer, Delco-Remy Div., G. M. Corp., Anderson, Ind. 1943

CROUT, PRESCOTT D., Assistant Professor of Mathematics, Massachusetts Institute of Technology, Cambridge, Mass. 1937

CROWDER, BERT A., Assistant Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1941

CUDWORTH, JAMES R., Director, School of Mines, Professor of Mining Engineering, University of Alabama, University, Ala. 1934

CULLIMORE, ALLAN R., President, Newark College of Engineering, Newark, N. J. (*Vice President, 1943–44; Member of Council, 1940–43.*) 1914

CULVER, EDWARD G., Teacher of Drawing, Bay City Junior College, Bay City, Mich. 1941

CUMBERLAND, ROBERT W., Assistant Professor of English, The Cooper Union, New York, N. Y. 1944

CUMMINGS, HAROLD N., Vice President, Newark College of Engineering, Newark, N. J. 1930

CUNNINGHAM, CHARLES W., Assistant Professor of Civil Engineering, College of the City of New York, New York City, N. Y. 1936

CUNNINGHAM, JOHN B., Professor of Metallurgy and Ore Dressing, University of Arizona, Tucson, Ariz. 1936

CURRAN, THOMAS M., Associate Professor of Naval Architecture, Webb Institute of Naval Architecture, New York City 1943

CURRY, WALTER A., Associate Professor of Electrical Engineering, Columbia University, New York City 1928

CURTIS, DONALD D., Professor of Mechanics and Hydraulics, Clemson College, Clemson College, S. C. 1923

CURTIS, HARRY A., Dean of Engineering, University of Missouri, Columbia, Mo. (*Member of Council, 1940–43.*) 1938

CUSHMAN, PAUL A., Test Engineer, McGill Mfg. Co., 803 Brown St., Valparaiso, Ind. 1922

CUTLER, ALVIN S., Professor and Head, Dept. of Civil Engineering, University of Minnesota, Minneapolis, Minn. 1926

CUTSHALL, CHESTER S., Professor of Applied Mechanics, Purdue University, Lafayette, Ind. 1941

DACE, FRED E., Associate Professor of Electrical Engineering; Director of Evening Division, Bradley Polytechnic Institute, Peoria, Ill. 1942

DAGGETT, P. H., Dean, College of Engineering, Rutgers University, New Brunswick, N. J. (*Member of Council, 1921–4; Vice President, 1935–36.*) 1910

DAHL, OTTO G. C., Engineer, Jackson & Moreland, Engineers, 31 St. James Ave., Boston, Mass. **In military service** 1932

DAHLENE, OSCAR, Professor and Head, Dept. of Mechanics, University of Alabama, University, Ala. 1936

DAKE, EARL D., Professor of Civil Engineering, South Dakota School of Mines, Rapid City, S. D. 1940

DALE, R. BURDETTE, Consulting Management and Mechanical Engineer, 25 Broad St., New York City 1921

DALEY, JOHN L., Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. **In military service** 1940

DALTON, BLANCHE H., Librarian, University of California, Berkeley, Calif. 1944

D'AMATO, GUY A., Instructor in Engineering Drawing, Tufts College, Medford, Mass. 1944

DANA, FOREST C., Professor of General Engineering, Iowa State College, Ames. Iowa 1923

DANGEL, HERBERT A., Associate Professor of Mathematics, University of Cincinnati, Cincinnati, Ohio 1944

DANIEL, JOHN L., Dean, Division of Graduate Studies, Head, Dept. of Chemistry, Georgia School of Technology, Atlanta, Ga. 1943

DANIELS, JOHN M., Director, Division of Student Personnel and Welfare, Carnegie Institute of Technology, Pittsburgh, Pa. 1943

DANIELS, JOSEPH, Professor of Mining Engineering and Metallurgy, University of Washington, Seattle, Wash. 1910

DANIELS, WALTER T., Associate Professor of Civil Engineering, Howard University, Washington, D. C. 1942

DASHER, BENJAMIN J., Instructor in Electrical Engineering, Georgia School of Technology, Atlanta, Ga. 1943

DAUGHERTY, ROBERT L., Professor of Mechanical Engineering, California Institute of Technology, Pasadena, Calif. 1942

DAVIDSON, ARTHUR J., Instructor in Civil Engineering, University of Idaho, Moscow, Idaho. **In military service** 1940

DAVIDSON, GEORGE A., Assistant Professor of Electrical Engineering, 1101 Highland Ave., Bluefield, W. Va. 1943

DAVIDSON, HARRY L., Supt., Virginia Mechanics Institute, Richmond, Va. 1943

DAVIDSON, J. BROWNLEE, Professor and Head, Department of Agricultural Engineering, Iowa State College, Ames, Iowa 1915

DAVIES, C. E., Secretary, American Society of Mechanical Engineers, 29 West 39th Street, New York City. (*Member of Council, 1934–7.*) **In military service** 1925

DAVIS, ALTON F., Vice President and Secretary, The James F. Lincoln Arc Welding Foundation, 12818 Coit Road, Cleveland, Ohio 1942

DAVIS, ARTHUR W., Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1943

DAVIS, CALVIN V., Project Engineer, Fontana Dam, T.V.A., 27 Circle Hill Drive, Knoxville, Tenn. 1942

DAVIS, GEO. JACOB, JR., Dean and Professor of Civil Engineering, University of Alabama, University, Ala. 1913

DAVIS, GEORGE W., Acting Director, Division of Trades, Hampton Institute, Hampton, Va. 1943

DAVIS, HARMER E., Associate Professor of Civil Engineering, University of California, Berkeley, Calif. 1933

DAVIS, HARVEY N., President, Stevens Institute of Technology, Hoboken, N. J. (*Member of Council, 1934–7.*) 1929

DAVIS, HOWARD L., Vocational Director, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1929

DAVIS, JESSE H., Professor and Head, Dept. of Mechanical Engineering, University of Louisville, Louisville, Ky. 1944

DAVIS, LOUIS E., Assistant Professor of Industrial Engineering, Georgia School of Technology, Atlanta, Ga. 1942

DAVIS, RAYMOND E., Professor of Civil Engineering, Director, Engineering Materials Laboratory, University of California, Berkeley, Calif. 1913

DAVIS, ROLAND P., Professor of Civil Engineering, West Virginia University, Morgantown, W. Va. 1932

DAVIS, STEPHEN S., Instructor in Mechanical Engineering, Howard University, Washington, D. C. 1941

DAVIS, WATSON M., Professor of Mechanical Engineering, Cornell College, Mount Vernon, Iowa 1939

DAVISON, ALBERT W., Scientific Director, Owens Corning Fiberglas Corp., Newark, Ohio 1936

DAWES, CHESTER L., Associate Professor of Electrical Engineering, Harvard University, Cambridge, Mass. 1915

DAWES, LYMAN M., Assistant Professor of Industrial Applications, Massachusetts Institute of Technology, Cambridge, Mass. 1926

DAWSON, CHARLES H., Instructor in Engineering, University of Rochester, Rochester, N. Y. **In military service** 1939

DAWSON, EUGENE F., Professor and Director, School of Mechanical Engineering, University of Oklahoma, Norman, Okla. 1942

DAWSON, F. M., Dean, College of Engineering, State University of Iowa, Iowa City, Iowa. (*Member of Council, 1941–4.*) 1910

DAWSON, JOHN U., Instructor in Civil Engineering, University of Colorado, Boulder, Colo. 1942

DAWSON, RAYMOND F., Associate Professor of Civil Engineering; Assistant Director, Bureau of Engineering Research, University of Texas, Austin, Texas 1935

DEAN, GEORGE T., Assistant Professor of Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1941

DEAN, JOHN E., Instructor in Electrical Engineering, Iowa State College, Ames, Iowa 1943

DEARBORN, R. H., Dean, School of Engineering, Director, Engineering Experiment Station, Oregon State College, Corvallis, Ore. 1917

DE BAUFRE, WM. L., Chairman, Department of Engineering Mechanics, University of Nebraska, Lincoln, Nebr. 1920

DECKER, FLOYD A., Professor of Electrical Engineering, University of New Mexico, Albuquerque, N. M. 1940

DEESZ, LOUIS A., Dean of Engineering, Youngstown College, Youngstown, Ohio 1943

DE GARMO, E. PAUL, Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1939

DEGLER, HOWARD E., Professor and Chairman, Dept. of Mechanical Engineering, University of Texas, Austin, Texas. (*Member of Council, 1940–43.*) 1930

DE JONG, SYBREN H., Lecturer in Civil Engineering, University of Toronto, Toronto, Ont. 1943

DELANEY, WARD, President, Institute of Textile Technology, Charlottesville, Va. 1944

DELAUBENFELS, C. R., Instructor in Aeronautical Engineering, Los Angeles City College, Los Angeles, Calif. 1939

DELENK, W. N., Chief Engineer, McKinney Tool & Mfg. Co., Cleveland, Ohio 1939

DELL, GEORGE H., Assistant Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1932

DELLER, ANTHONY W., Patent Counsel, Chemical Engineer, 67 Wall St., New York City 1940

DELLER, RUSSEL A., Technical Employment Manager, Bell Telephone Laboratories, 463 West Street, New York, N. Y. (*Member of Council, 1944–47.*) 1931

DEMOREST, DANA J., Professor of Metallurgy, The Ohio State University, Columbus, Ohio 1943

DE MOYER, ROBERT, Assistant Professor of Civil Engineering, Lafayette College, Easton, Pa. 1938

DENIS, BROTHER A., Professor and Head, Dept. of Engineering Drawing, Manhattan College, New York City 1939

DENNISON, B. C., Professor of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1936

DENT, JOHN A., Professor of Mechanical and Aeronautical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1911

DENT, JOSEPH B., Associate Professor of Engineering Drawing, Virginia Polytechnic Institute, Blacksburg, Va. 1935

DERLETH, CHAS., JR., Professor Emeritus of Civil Engineering, University of California, Berkeley, Calif. 1904

DE RONDE, LOUIS A., Assistant Professor of Mathematics, New York University, New York City 1936

DEVINE, JAMES J., Associate Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1930

DEVINE, J. JAMES, Assistant Professor of Engineering Drawing, Northeastern University, Boston, Mass. 1935

DEVOR, ELMER L., U. S. Rubber Co., N. Y. Engineering Staff, New York City 1938

DEWITT, C. C., Professor and Chairman of Chemical Engineering and Chemistry, Michigan State College, East Lansing, Mich. 1937

DIAKOFF, ALEXIS J., Professor and Head, Department of Mechanical Engineering, University of North Dakota, Grand Forks, N. D. 1938

DIBERT, HERBERT M., Secretary and Treasurer, W. & L. E. Gurley, Troy, N. Y. 1913

DICKEY, DONALD W., Assistant Professor of Electrical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1944

DICKINSON, JOHN L., Assistant Chief Engineer, Engineering School, Cal-Aero Technical Institute, Los Angeles, Calif. 1944

DIEFENDORF, ADELBERT, Professor and Head, Dept. of Civil Engineering, University of Utah, Salt Lake City, Utah 1922

DIETZ, ALBERT G., Assistant Professor of Structural Design and Materials, Massachusetts Institute of Technology, Cambridge, Mass. 1940

DIETZ, J. W., Manager, Personnel Relations Manager, Western Electric Co., Inc., 195 Broadway, New York City 1911

DILLINGHAM, HARLEY C., Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1929

DILLMAN, GROVER C., President, Michigan College of Mining and Technology, Houghton, Mich. 1936

DIMATTEO, JOHN E., Assistant Professor of Engineering Drawing, Manhattan College, New York City 1942

DIMICK, CHESTER E., Captain, Professor of Mathematics, U. S. Coast Guard Academy, New London, Conn. 1933

DIRKS, HENRY B., Dean of Engineering, Michigan State College, East Lansing, Mich. (*Member of Council, 1932–35.*) 1920

DISQUE, FREDERICK C., Instructor in Chemistry, Pratt Institute, Brooklyn, N. Y. 1940

DISQUE, ROBERT C., President, Drexel Institute of Technology, Philadelphia, Pa. (*Member of Council, 1928–31.*) 1927

DISTLER, THEODORE A., President, Franklin and Marshall College, Lancaster, Pa. 1928
DIX, L. E., Professor of Mathematics, Norwich University, Northfield, Vt. 1917
DIXON, DON P., Associate Professor of Mechanical Drawing, Louisiana State University, University, La. 1935
DIXON, HARRY S., North American Aviation, Inc., 3505 W. 84th Place, Inglewood, Calif. 1938
DIXON, TOD G., Professor and Head, Dept. of Chemical Engineering, Pratt Institute, Brooklyn, N. Y. 1932
DIXON, WISTAR R., Application Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1944
DOAN, GILBERT E., Professor and Head, Dept. of Metallurgical Engineering, Lehigh University, Bethlehem, Pa. 1936
DOBBINS, GEORGE S., Assistant Professor of Engineering Drawing and Machine Design, University of Colorado, Boulder, Colo. 1944
DOBBS, F. E., Principal, Wentworth Institute, Boston, Mass. 1941
DODD, CHARLES M., Professor and Head, Dept. of Ceramic Engineering, Iowa State College, Ames, Iowa 1937
DODDS, JOHN S., Professor of Civil Engineering, Iowa State College, Ames, Iowa 1928
DODGE, BARNETT F., Professor of Chemical Engineering, Yale University, New Haven, Conn. 1937
DODGE, ELDON R., Director of Engineering, Fairbanks Morse & Co., Madison, Wis. 1942
DODGE, HOMER L., President, Norwich University, Northfield, Vt. (*Member of Council, 1942–45.*) 1919
DODGE, JOHN F., Professor and Head, Division of Petroleum Engineering, University of Southern California, Los Angeles, Calif. 1933
DODGE, RUSSELL A., Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich 1938
DOERINGSFELD, HARRY A., Associate Professor of Mathematics and Mechanics, University of Minnesota, Minneapolis, Minn. 1932
DOERR, LAWRENCE O., Assistant Professor of Mechanical Engineering, North Dakota Agricultural College, Fargo, N. D. 1935
DOGGETT, L. A., Professor of Electrical Engineering, Pennsylvania State College, State College, Pa. 1914
DOHERTY, ROBERT E., President, Carnegie Institute of Technology, Pittsburgh, Pa. (*President, 1943–44; Member of Council, 1930–33, 1943–.*) 1923
DOHRENWEND, CLAYTON O., Research Engineer, Armour Research Foundation, Chicago, Ill. 1935
DOLAN, THOMAS J., Associate Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. **In military service** .. 1936
DOLL, ALFRED W., Head, Dept of Engineering Physics, Pratt Institute, Brooklyn, N. Y. 1926
DOLL, THEODORE, Engineer, Standard Oil Co. (Ind.), Whiting, Ind. (33 E. Exchange Ave., Crete, Ill.) 1936
DOLVE, ROBERT M., Dean, School of Engineering, Professor of Mechanical Engineering, North Dakota State College, Fargo, N. D. 1926
DOMONOSKE, ARTHUR B., Executive Head, Department of Mechanical Engineering, Stanford University, Stanford University, Calif. (*Member of Council, 1935–8.*) **In military service** 1913
DONNELL, LLOYD H., Research Professor of Mechanics, Director, Mech. and Aero. Res. Lab., Illinois Institute of Technology, Chicago, Ill. .. 1939

DONNELL, PHILIP S., Dean, Division of Engineering, Oklahoma A. & M. College, Stillwater, Okla. In military service 1927
DONNELLY, HAROLD G., Assistant Professor of Chemical Engineering, Wayne University, Detroit, Mich. 1943
DONOVAN, EDWARD T., Assistant Professor of Mechanical Engineering, University of New Hampshire, Durham, N. H. (Principal Specialist in Engineering Education, ESMWT, Washington, D. C.) 1929
DOODY, THOMAS C., Professor of Chemical Engineering, North Carolina State College, Raleigh, N. C. 1939
DOOLEY, C. R., Manager, Industrial Relations, Socony-Vacuum Corps., 26 Broadway, New York, N. Y. (Director, Training Within Industry, War Manpower Com., Washington, D. C.) (*Member of Council, 1929–32.*) 1907
DOOLITTLE, JESSE S., Associate Professor of Mechanical Engineering, Pennsylvania State College, State College, Pa. 1929
DORFMAN, LEO O., Advisory Engineer, Patent Dept., Westinghouse E. & M. Co., East Pittsburgh, Pa. 1944
DORN, WESLEY N., Special Assistant, Business Div., Baltimore Dept. of Ed., Baltimore, Md. 1943
DORNBERGER, WERNER W., Assistant Professor of Architecture, Assistant Supervising Architect, University of Texas, Austin, Texas 1938
DOTY, L. DONALD, Associate Professor and Head, Dept. of Hydraulic Engineering, Cornell University, Ithaca, N. Y. 1930
DOUGHERTY, JOHN W., Assistant Engineer, U. S. Eng. Dept., Box 5180 Metro, Los Angeles, Calif. In military service . . 1940
DOUGHERTY, N. W., Dean of Engineering, University of Tennessee, Knoxville, Tenn. (*First Vice President, 1941–45; Member of Council, 1941–44.*) 1937
DOUGHTIE, VENTON L., Professor of Mechanical Engineering, University of Texas, Austin, Texas 1930
DOUGLAS, EARL C., Director, Vocational Education, Joliet Junior College, Joliet, Ill. 1930
DOUGLAS, JOHN F. H., Professor of Electrical Engineering, Marquette University, Milwaukee, Wis. 1910
DOUGLAS, MALCOLM S., Associate Professor of Civil Engineering, Case School of Applied Science, Cleveland, Ohio 1925
DOUGLASS, CLARENCE E., Professor of Engineering Drawing, University of Washington, Seattle, Wash. 1943
DOUGLASS, IRWIN B., Associate Professor and Acting Head, Dept. of Chemistry, University of Maine, Orono, Me. 1941
DOUGLASS, RAYMOND D., Professor of Mathematics, Massachusetts Institute of Technology, Cambridge, Mass. 1937
DOW, FREDERIC A., Supervisor, Engineering Training, Douglas Aircraft Co., Inc., 6108 Olive Ave., Long Beach, Calif. 1943
DOW, WILLIAM G., Associate Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1929
DOWELL, DAWSON, Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1936
DOWLING, EDWARD J., Instructor in Drawing, University of Detroit, Detroit, Mich. 1942
DOWMAN, W. S., Manager, Salary Personnel Dept., Goodyear Aircraft Corp., Akron, Ohio 1941
DOWNING, DONALD G., Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1934

DOWNING, LEWIS K., Dean and Professor of Civil Engineering, Howard University, Washington, D. C. 1929
DOWNING, RODERICK L., Professor of Civil Engineering, University of Colorado, Boulder, Colo. 1926
DOWNS, JAMES B. T., Instructor in Mechanical Engineering, The Rice Institute, Houston, Texas 1939
DOWNS, WILLIAM S., Professor of Railway Hydraulic Engineering, West Virginia University, Morgantown, W. Va. 1939
DOWS, HAROLD W., Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1934
DOYLE, FRANK B., Director of Research, Ingersoll-Rand Company, Phillipsburg, N. J. 1925
DRAFFIN, JASPER O., Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1917
DRAY, RICHARD C., Assistant Professor of Mechanical Engineering, University of Rochester, Rochester, N. Y. 1943
DREESE, ERWIN E., Professor and Chairman, Dept. of Electrical Engineering, The Ohio State University, Columbus, Ohio 1929
DREW, THOMAS B., Associate Professor of Chemical Engineering, Columbia University, New York City 1940
DRIER, ROY W., Associate Professor of Metallurgy, Michigan College of M. & T., Houghton, Mich. **In military service** 1938
DRISCOLL, WILLIAM G., Assistant Professor of Physics and Mathematics, Villanova College, Villanova, Pa. 1939
DRUMMOND, GARRETT B., Assistant Professor of Engineering, New Mexico School of Mines, Socorro, N. M. 1943
DUCKERING, W. E., Professor of Civil Engineering; Dean of the University, University of Alaska, College, Alaska 1917
DUDLEY, A. M., Advisory Engineer, Retired, Westinghouse E. & M. Co., P.O. Box 248, Oakmont, Pa. (*Member of Council, 1931–34.*) 1942
DUDLEY, BEVERLY, Western Editor, Electronics, McGraw-Hill Publishing Co., 520 N. Michigan Ave., Chicago 11, Ill. 1942
DUDLEY, SAMUEL W., Dean, School of Engineering, Yale University, New Haven, Conn. (*Member of Council, 1936–39.*) 1921
DUDLEY, WINSTON M., Assistant Professor of Applied Mechanics, Case School of Applied Science, Cleveland, Ohio 1934
DUFF, C. M., Professor of Engineering Mechanics, University of Nebraska, Lincoln, Nebr. 1912
DUKE, CHARLES M., Instructor in Civil Engineering, University of California, Berkeley, Calif. 1939
DUMBLE, WILSON R., Assistant Professor of English, The Ohio State University, Columbus, Ohio 1932
DUNCAN, DAVID C., Professor of Physics, The Pennsylvania State College, State College, Pa. 1939
DUNCAN, DONALD S., Instructor in Physics, Pratt Institute, Brooklyn, N. Y. 1938
DUNCAN, SYDNEY F., Associate Professor of Mechanical Engineering, University of Southern California, Los Angeles, Calif. 1937
DUNCOMBE, CHARLES G., Professor of Chemical Engineering, University of Detroit, Detroit, Mich. 1936
DUNHAM, CLARENCE W., Associate Professor of Civil Engineering, Yale University, New Haven, Conn. 1934
DUNHOLTER, R. J., Assistant Professor of Mathematics and Mechanics, University of Cincinnati, Cincinnati, Ohio 1943

DUNKIN, WILLIAM V., Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1944
DUNKLE, RALPH W., President, Ohio Institute of Technology, Greenville, Ohio 1940
DUNLAP, A. LEE, Associate Professor of Mechanical Engineering, Tulane University, New Orleans, La. 1934
DUNLOP, JOHN A., Assistant Professor of Geodesy and Transportation Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1937
DUNN, CLARK A., Associate Professor of Civil Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1942
DUNN, COLON H., Instructor in Electrical Engineering, University of New Hampshire, Durham, N. H. 1942
DUNSTAN, GILBERT H., Associate Professor of Sanitary Engineering, University of Alabama, University, Ala. 1928
DUPRIEST, JOHN R., Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1919
DURAND, W. F., Professor Emeritus, Stanford University, Calif. 1899
DURBIN, FRANK M., Professor of Physics, Oklahoma A. & M. College, Stillwater, Okla. 1940
DURLAND, M. A., Professor of Machine Design, Assistant Dean, Kansas State College, Manhattan, Kans. 1926
DUSINBERRE, G. M., Assistant Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. **In military service** .. 1939
DUTTON, DONNELL W., Director, Daniel Guggenheim School of Aeronautics, Georgia School of Technology, Atlanta, Ga. 1943
DUTTON, HENRY P., Dean, Evening Division, Chairman, Dept. of Industrial Engineering, Illinois Institute of Technology, Chicago, Ill. 1935
DUVALL, W. CLINTON, Professor and Head, Dept. of Electrical Engineering, University of Colorado, Boulder, Colo. 1919
DWYER, ORRINGTON E., Assistant Professor of Chemical Engineering, University of Rochester, Rochester, N. Y. 1941
DYCHE, H. E., Professor and Head, Dept. of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1914
DYE, EDWARD R., Professor and Head, Dept. of Civil Engineering, Montana State College, Bozeman, Mont. 1943
DYER, WILBUR E., Dean of the College, Lewis School of Aeronautics, Lockport, Ill. 1943
EAMES, JESSE J., Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1935
EARLE, CHESTER R., Associate Editor, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, 4, Ill. 1922
EARLE, S. B., Dean of Engineering, Director of the Engineering Experiment Station, Clemson Agricultural College, Clemson College, S. C. *(President, 1937–38; Vice President, 1935–36; Member of Concil, 1927–30; 1937–.)* 1912
EARNEST, G. BROOKS, Associate Professor of Surveying, Executive Secretary, College Administration, Case School of Applied Science, Cleveland, Ohio 1940
EASTMAN, AUSTIN V., Professor of Electrical Engineering, University of Washington, Seattle, Wash. 1939
EASTON, WILLIAM H., Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1944
EATON, PAUL B., Professor and Head, Department of Mechanical Engineering, Lafayette College, Easton, Pa. 1931

EBAUGH, NEWTON C., Professor and Head of Department of Mechanical Engineering, University of Florida, Gainesville, Fla. 1931
EBAUGH, W. C., Professor of Chemistry, Denison University, Granville, Ohio 1908
EBERHART, HOWARD D., Associate Professor of Civil Engineering, University of California, Berkeley, Calif. 1940
ECKEL, C. L., Dean, College of Engineering, Professor of Civil Engineering, University of Colorado, Boulder, Colo. (*Member of Council, 1934–7.*) 1914
ECKERMAN, EDWARD H., Instructor in Mechanical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1943
ECKHARD, G. F., Dean, College of Engineering, University of Vermont, Burlington, Vt. (*Member of Council, 1937–40*) 1910
ECKHARDT, CARL J., JR., Professor of Mechanical Engineering, University of Texas, Austin, Texas 1929
ECKLE, JOHN N., Assistant Professor of Engineering Drawing, Yale University, New Haven, Conn. 1928
EDDY, CLARENCE L., Professor of Engineering Administration, Case School of Applied Science, Cleveland, O. 1910
EDDY, CORBIN T., Associate Professor of Metallurgy, Head, Dept. of Physical Metallurgy, Michigan College of M. & T., Houghton, Mich. 1937
EDELL, GERARD M., Associate Professor and Acting Head, Dept. of Chemical Engineering, Syracuse University, Syracuse, N. Y. 1936
EDGAR, ROBERT F., Professor of Theoretical and Applied Mechanics, University of Pittsburgh, Pittsburgh, Pa. 1920
EDGARTON, LEWIS S., Engineering Personnel Manager, Stromberg-Carlson Co., Rochester, N. Y. 1943
EDGECOMB, REX E., Assistant Professor of Civil Engineering, University of Nebraska, Lincoln, Nebr. 1941
EDGECOMBE, ARTHUR C., Head, Department of Engineering, Geneva College, Beaver Falls, Pa. 1937
EDISON, OSKAR E., Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebr. 1922
EDSTROM, ALFRED E., Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. 1944
EDWARDS, FRANK W., Associate Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. 1942
EDWARDS, HENRY L., Assistant Professor of Chemistry, Georgia School of Technology, Atlanta, Ga. 1944
EDWARDS, JOHN C., Instructor in Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. In military service 1939
EDWARDS, WILLIAM W., Head, Steam Engineering Department, Wentworth Institute, Boston, Mass. 1929
EGGERS, HENRY C. T., Associate Professor of Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. 1922
EGILSRUD, FRIDTJOF S., Head, Mechanical Engineering Laboratory, Pratt Institute, Brooklyn, N. Y. 1928
EGRY, CHARLES R., Associate Professor of Mechanical Engineering, University of Notre Dame, Notre Dame, Ind. 1941
EICHLER, JOHN O., Assistant Professor of Civil Engineering, Syracuse University, Syracuse, N. Y. 1939
ELBIN, GUY H., Bridge Engineer, Franklin Co., 555 Evening St., Worthington, Ohio 1924
ELGIN, JOSEPH C., Professor and Chairman, Dept. of Chemical Engineering, Princeton University, Princeton, N. J. (*Member of Council, 1942–45.*) 1931

ELIASSEN, ROLF, Associate Professor of Sanitary Engineering, New York University, New York City 1943
ELL, CARL S., President, Northeastern University, Boston, Mass. (*Member of Council, 1940–43.*) 1917
ELLENWOOD, FRANK O., John Edson Sweet Professor of Engineering, Chairman, Dept. of Heat-Power Engineering, Cornell University, Ithaca, N. Y. 1929
ELLINGSON, MARK, President, Rochester Institute of Technology, Rochester, N. Y. 1944
ELLIOTT, BEN G., Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis. (*Member of Council, 1931–34.*) 1912
ELLIOTT, EDWARD C., President, Purdue University, Lafayette, Ind. 1928
ELLIOTT, ROY W., Comptroller and Professor of Engineering, Municipal University of Wichita, Wichita, Kansas 1943
ELLIS, CHARLES A., Professor of Structural Engineering, Purdue University, Lafayette, Ind. 1934
ELLIS, W. T., Professor and Head, Dept. of Power and Fuel Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1910
ELLITHORN, HAROLD E., Assistant Professor of Electrical Engineering, University of Notre Dame, Notre Dame, Ind. 1941
ELROD, STEPHEN B., Assistant Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1940
ELY, JOHN A., Adjunct Professor of Civil Engineering, Cooper Union, New York City 1914
EMERSON, CHERRY L., Vice President, Georgia School of Technology, Atlanta, Ga. 1943
EMERSON, L. A., Assistant Dean, College of Engineering, Cornell University, Ithaca, N. Y. 1929
EMERSON, WALTER D., Professor of Mechanical Engineering, Norwich University, Northfield, Vt. 1920
EMERY, KENNETH G., Kelly Field, Texas. **In military service** 1940
EMMONS, WALTER J., Associate Professor of Highway Engineering, University of Michigan, Ann Arbor, Mich. 1923
EMRICK, PAUL S., Electrical Engineer, Lafayette, Ind. 1914
ENBURG, JACK T., Instructor in Engineering Drawing, University of Iowa, Iowa City, Iowa. **In military service** 1943
ENDSLEY, L. E., Lecturer in Mechanical Engineering, University of Pittsburgh, 516 East End Avenue, Pittsburgh, Pa. 1907
ENEY, WILLIAM J., Associate Professor of Civil Engineering, Lehigh University, Bethlehem, Pa. 1938
ENGEL, ERNEST D., Assistant Professor of General Engineering, University of Washington, Seattle, Wash. 1935
ENGER, MELVIN L., Dean, College of Engineering, Director, Engineering Experiment Station, Professor of Mechanics and Hydraulics, University of Illinois, Urbana, Ill. (*Member of Council, 1921–24; Vice President, 1938–39.*) 1907
ENSIGN, N. E., Associate Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1915
ENTWISLE, FRANK N., Professor of Physics, Newark College of Engineering Newark, N. J. 1927
EPPELSHEIMER, DANIEL S., Research Professor of Industrial Engineering, Acting Director, Engineering Experiment Station, University of New Hampshire, Durham, N. H. 1940
EPSTEIN, BENJAMIN, Mathematician, Hdq. Quality Control, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1940

ERIKSEN, EDWARD L., Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. (*Member of Council, 1943–46.*) 1937

ERMENC, JOSEPH J., Assistant Professor of Mechanical Engineering, Thayer School of Engineering, Hanover, N. H. 1941

ERNST, GEORGE C., Senior Engineer, Div. Timber Mechanics, Forest Products Lab., Madison, Wis. 1930

ERNST, ROBERT C., Professor and Head, Dept. of Chemical Engineering, University of Louisville, Louisville, Ky. (*Member of Council, 1939–42.*) 1932

ESHBACH, OVID W., Dean, Northwestern Technological Institute, Evanston, Ill. (*Member of Council, 1936–39.*) 1926

ESPY, WILLIAM N., Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1943

ESSIGMANN, MARTIN W., Visiting Instructor in Electrical Engineering, Massachusetts Institute of Technology, 470 Atlantic Ave., Boston, Mass. 1941

ESTEP, THOMAS G., Professor and Acting Head, Dept. of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1938

EUBANKS, IRVING S., Assistant Professor of Civil Engineering, The Citadel, Charleston, S. C. 1943

EVANS, F. H., District Supt., U. S. Employment Service, Poughkeepsie, N. Y. 1907

EVANS, FREDERICK J., Assistant Professor of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1944

EVANS, FREDERICK R., Assistant Professor of Mechanical Engineering, Massachuetts Institute of Technology, Cambridge, Mass. 1944

EVANS, H. S., Professor of Electrical Engineering, University of Colorado, Boulder, Colo. (*President, 1931-32; Vice President, 1920–1; Member of Council, 1931–.*) 1905

EVANS, JAMES C., Director, Dept. of Engineering, West Virginia State College, Institute, W. Va. 1943

EVANS, THOMAS H., Associate Professor of Civil Engineering, University of Virginia, University, Va. **In military service** 1936

EVANS, WESTON S., Professor of Civil Engineering, University of Maine, Orono, Me. 1922

EVERETT, FRANKLIN L., Assistant Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. 1939

EVERETT, HAROLD A., Professor and Head, Dept., Mechanical Engineering, Pennsylvania State College, State College, Pa. 1924

EVERITT, WILLIAM L., Professor and Head, Dept. of Electrical Engineering, University of Illinois, Urbana, Ill. 1927

EVINGER, M. I., Professor of Civil Engineering, University of Nebraska, Lincoln, Nebr. 1926

EWING, D. D., Professor and Head, School of Electrical Engineering, Purdue University, Lafayette, Ind. 1910

EYRE, THOMAS T., Professor of Mechanical Engineering, University of Southern California, Los Angeles, Calif. 1909

FABEL, DONALD C., Professor and Head, Dept. of Mechanical Engineering, Fenn College, Cleveland, Ohio. **In military service** 1930

FADUM, RALPH E., Assistant Professor of Soil Mechanics, Purdue University, Lafayette, Ind. 1944

FAHNESTOCK, MAURICE K., Research Professor of Mechanical Engineering, Assistant Director, Engineering Experiment Station, University of Illinois, Urbana, Ill. 1943

Faig, John T., President, Ohio Mechanics Institute, Cincinnati, O. (*Vice President, 1918–9.*) 1899
Fair, Gordon M., Gordon McKay Professor of Sanitary Engineering, Harvard Engineering School, Cambridge, Mass. 1926
Fairbanks, Harold V., Assistant Professor of Chemical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1940
Fairbanks, Oscar W., Associate Professor of Drawing and Design, Michigan State College, East Lansing, Mich. 1937
Fairburn, A. John B., Professor and Head, Dept. of Electrical Engineering, University of Akron, Akron, Ohio 1927
Fairchild, Edward L., Assistant Professor of Industrial Engineering, Brown University, Providence, R. I. 1942
Faircloth, James M., Associate Professor of Civil Engineering, University of Alabama, University, Ala. 1940
Faires, Virgil M., Professor and Head, Dept. of Management Engineering, A. & M. College of Texas, College Station, Texas. (*Member of Council, 1939–42.*) 1925
Fairfield, John G., Professor of Heat Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1922
Fairman, Seibert, Professor of Applied Mechanics, Purdue University, Lafayette, Ind. (*Member of Council, 1941–4.*) 1921
Faith, W. Lawrence, Professor and Head, Dept. of Chemical Engineering, University of Iowa, Iowa City, Iowa 1934
Falls, Eugene K., Assistant Professor of Mechanical Engineering, University of Rochester, Rochester, N. Y. 1941
Farnham, Charles S., Lecturer in Civil Engineering, Yale University, New Haven, Conn. 1908
Farnham, George W., Vice President, Irwin-Farnham Publishing Co., 332 S. Michigan Ave., Chicago, Ill. 1922
Farnham, Walter E., Professor of Engineering Drawing, Tufts College, Medford, Mass. (*Member of Council, 1930–33.*) 1919
Farris, Marshall E., Dean of Engineering, University of New Mexico, Albuquerque, N. M. 1925
Faucett, Max A., Associate Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1935
Fawcett, Charles D., Professor of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. 1935
Feiker, Frederick M., Dean, School of Engineering, George Washington University, Washington, D. C. (*Member of Council, 1937–40.*) 1936
Felgar, J. H., Dean Emeritus; Professor of Engineering, University of Oklahoma, Norman, Okla. (*Member of Council, 1920–3.*) 1912
Fellows, Julian R., Associate Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1937
Fenn, Irwin H., Professor of Mathematics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1943
Fenton, Chauncey L., Colonel and Professor, Dept. of Chemistry and Electricity, United States Military Academy, West Point, N. Y. 1930
Fenton, Fred C., Professor and Head, Dept. of Agricultural Engineering, Kansas State College, Manhattan, Kansas 1944
Fenwick, Harold H., Associate Professor of Engineering Drawing, University of Louisville, Louisville, Ky. 1927
Feodoroff, Nicholas V., Research Associate in Civil Engineering, Columbia University, New York City 1943
Ferguson, Joseph L., Plant Engineer, Glamorgan Pipe & Foundry Co., Lynchburg, Va. 1938

FERGUSON, O. J., Professor of Electrical Engineering, and Dean, College of Engineering, Director, Engineering Experiment Station, University of Nebraska, Lincoln, Nebr. (*President, 1939–40; Vice President, 1923–4; Member of Council, 1939–.*) 1908

FERGUSON, PHIL M., Professor and Chairman, Dept. of Civil Engineering, University of Texas, Austin, Texas 1930

FERNALD, ERNEST M., Professor of Mechanical Engineering, Lafayette College, Easton, Pa. 1927

FERNOW, BERNHARD E., Professor of Mechanical Engineering, Clemson College, Clemson College, S. C. 1929

FERRETTI, ALFRED J., Professor of Mechanical Engineering, Northeastern University, Boston, Mass. 1925

FERRY, ARTHUR L., Branch Manager, The A. Lietz Co., 1965 North Berendo St., Los Angeles 15, Calif. 1940

FESSENDEN, EDWIN A., Emeritus Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1912

FIEDLER, GEORGE J., Assistant Professor of Electrical Engineering, University of California, Berkeley, Calif. 1940

FIELD, FLOYD, Dean of Men, Director of Personnel, Georgia School of Technology, Atlanta, Ga. 1919

FIELD, WOOSTER B., Professor of Engineering Drawing, The Ohio State University, Columbus, Ohio 1941

FIFE, SAMUEL T., Professor of Electrical Engineering, University of Louisville, Louisville, Ky. 1927

FILES, CARL W., Assistant Professor of Mechanical Engineering, A. & M. College of Texas, College Station, Texas 1943

FILIPETTI, GEORGE, Professor of Economics and Business Administration, University of Minnesota, Minneapolis, Minn. 1931

FINCH, F. R., Associate Professor of Mechanism and Engineering Drawing, University of Michigan, Ann Arbor, Mich. 1913

FINCH, JAMES K., Renwick Professor of Civil Engineering, Associate Dean, Columbia University, New York City 1925

FINCH, STANLEY P., Professor of Civil Engineering, University of Texas, Austin, Texas 1935

FINDLAYSON, FRANK S., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1943

FINDLEY, WILLIAM N., Assistant Professor of T. & A. Mechanics, University of Illinois, Urbana, Ill. 1943

FINNEGAN, JOSEPH B., Professor and Director, Dept. of Fire Protection Engineering, Illinois Institute of Technology, Chicago, Ill. (*Member of Council, 1933–36.*) 1926

FISCHER, BERNHARD, Instructor in Electronics and Mathematics, University of California, Berkeley, Calif. 1943

FISCHER, DON A., Instructor in Electrical Engineering, Washington University, St. Louis, Mo. 1941

FISH, F. A., Professor of Electrical Engineering, Iowa State College, Ames, Ia. (*Member of Council, 1923–6.*) 1905

FISHER, DAVID A., Assistant Professor of Mechanical Engineering, Tufts College, Medford, Mass 1938

FISHER, EDWARD G., Assistant Professor of English, Colorado School of Mines, Golden, Colo. 1940

FISHER, EDGAR J., Assistant Director, Institute of International Education, 2 West 45th St., New York City 1943

FISHER, HILBERT A., Professor and Head, Dept. of Mathematics, Armed Services Coördinator, North Carolina State College, Raleigh, N. C. (*Member of Council, 1939–42.*) 1930

FISHER, JAMES, Dean Extension Division, Michigan College of Mines and Technology, Houghton, Mich. 1899

FISHER, ROBERT A., Associate Professor of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. **In military service** .. 1934

FISHMAN, SOLOMON, Associate Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. 1928

FISMER, DOROTHEA E., Supervisor, College Service, Westinghouse E. & M. Co., Pittsburgh, Pa. 1944

FITCH, AUSTIN E., Associate Professor of Architectural Construction, Washington University, St. Louis, Mo. 1941

FITCH, W. CHESTER, Instructor in Mechanical Engineering, Iowa State College, Ames, Iowa 1939

FITHIAN, JAMES H., Professor of Mathematics, Newark College of Engineering, Newark, N. J. 1934

FITTERER, G. R., Professor and Head, Dept. of Metallurgical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1941

FITTERER, J. C., Professor and Head, Dept. of Mathematics, Colorado School of Mines, Golden, Colo. 1912

FITZGERALD, JOHN A., Instructor in Electrical Engineering, University of Dayton, Dayton, Ohio 1941

FLANDERS, MILTON M., Dean of Faculty, Bliss Electrical School, Takoma Park, Washington, D. C. 1939

FLANDERS, ROGER L., Professor of Civil Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1940

FLANIGAN, ALAN E., Research Mechanical Engineer, University of California, Berkeley, Calif. 1941

FLATH, EARL H., Dean, School of Engineering, Southern Methodist University, Dallas, Texas 1925

FLEMING, ARTHUR P. M., Manager, Research and Education Dept., Metropolitan-Vickers Electrical Co., Manchester, England 1922

FLETCHER, L. J., Director of Training, Caterpillar Tractor Co., Peoria, Ill. (*Member of Council, 1942–45.*) 1941

FLINNER, ARTHUR O., Assistant Professor of Mechanical Engineering, Kansas State College, Manhattan, Kansas. **In military service** 1931

FLINSCH, HAROLD V., Assistant Professor of Civil Engineering, Bucknell University, Lewisburg, Pa. 1940

FLOYD, COLUMBUS, Instructor in Mechanical Engineering, University of Detroit, Detroit, Mich. 1940

FLYNN, EDMUND C., Professor of Civil Engineering, University of Santa Clara, Santa Clara, Calif. 1935

FOCHT, JOHN A., Professor of Civil Engineering, University of Texas, Austin, Texas 1935

FOCKE, HELEN M., Supervising Librarian, Case School of Applied Science, Cleveland, Ohio 1944

FOCKE, THEODORE M., Dean Emeritus, Case School of Applied Science, Cleveland, O. (*Member of Council, 1928–31.*) 1907

FOGARTY, WILLIAM P., Professor of General Engineering, St. Francis Xavier University, Antigonish, N. S. 1944

FOLK, EDWIN H., Professor of English, Georgia School of Technology, Atlanta, Ga. 1944

FOLK, JOHN T., Associate Professor of Civil Engineering, Louisiana Polytechnic Institute, Rouston, La. 1939

FOLK, SAMUEL B., Professor of Mechanics, The Ohio State University, Columbus, Ohio 1921
FOLSOM, RICHARD G., Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1943
FOLTZ, LEROY S., Professor and Head, Dept. of Electrical Engineering, Michigan State College, East Lansing, Mich. 1918
FOOS, CALDWELL B., Industrial Engineer, Kodak Park Works, Eastman Kodak Co., Rochester, N. Y. **In military service.** Box 352, Oak Ridge, Tenn. 1940
FOOTE, JAMES H., Supervising Engineer, Commonwealth & Southern Corp., Jackson, Mich. 1933
FORD, ALBERT D., Professor and Head, Dept. of Mechanical Engineering, University of New Mexico, Albuquerque, N. M. 1942
FORD, LESTER R., Professor and Chairman, Dept. of Mathematics, Illinois Institute of Technology, Chicago, Ill. 1939
FORMAN, ALEXANDER H., Professor and Head, Dept. of Electrical Engineering, West Virginia University, Morgantown, W. Va. 1937
FORNES, GASTON G., Assistant Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. **In military service** 1937
FORRESTER, JAMES D., Professor and Chairman, Dept. of Mining Engineering, Missouri School of Mines, Rolla, Mo. 1944
FORSTALL, WALTON, Project Engineer, Tennessee-Eastman Corp., 109 E. Holston Lane, Oak Ridge, Tenn. 1941
FORT, TOMLINSON, Dean of Graduate School, Lehigh University, Bethlehem, Pa. 1939
FOSS, MARTIN M., Vice Chairman of Board, McGraw-Hill Book Co., Inc., St., New York 18, N. Y. 1909
FOSS, RAY J., Instructor in Civil Engineering, University of Louisville, Louisville, Ky. 1942
FOSTER, CHARLES A. B., Assistant Professor of Engineering, Manager, Virginia Polytechnic Institute in Blacksburg, Va. 1943
FOSTER, EDWARD, Instructor in English, Georgia School of Technology, Atlanta, Ga. 1944
FOSTER, E. S., Electrical Engineer, Standard Transformer Co., R. F. D. 4, Warren, Ohio 1911
FOUNTAIN, ALVIN M., Associate Professor of English, North Carolina State College, Raleigh, N. C. 1937
FOURAKER, LEROY L., Associate Professor of Electrical Engineering, A. & M. College of Texas, College Station, Tex. 1924
FOURAKER, RAYMOND S., Professor of Electrical Engineering, North Carolina State College, Raleigh, N. C. 1929
FOWLER, RUSSELL W., Associate Professor of Mechanical Engineering, Extension Division, University of Wisconsin, Madison, Wis. 1934
FOX, BEAUVIS B., Instructor in Engineering Drawing, New York University, New York City 1943
FOX, FREDERICK H., Associate Professor of Civil Engineering, Tulane University of Louisiana, New Orleans, La. **In military service** 1922
FOX, ROBERT M., Professor of Civil Engineering, University of Southern California, Los Angeles, Calif. 1932
FRAAS, ARTHUR P., Test Engineer, Packard Motor Car Co., Detroit, Mich. 1942
FRAIM, PARKE B., Associate Professor of Physics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1926
FRAME, FLOYD H., Professor of Electrical Engineering, Missouri School of Mines, Rolla, Mo. 1924

FRANCE, VAN O., Manager, Industrial Training, Consolidated-VoHee Aircraft Corp., 2901 Westbridge, Fort Worth, Texas 1943
FRANCIS, SAMUEL A., Head, Department of Mathematics and Engineering, San Mateo Junior College, San Mateo, Calif. 1935
FRANKLIN, JOSEPH F., Methods Analyst, Employment Dept., Lockheed Aircraft Corp., Burbank, Calif. 1943
FRAZIER, FORREST F., Professor of Civil Engineering, Kansas State College, Manhattan, Kans. 1929
FRAZIER, RICHARD H., Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1927
FREBERG, C. R., Assistant Professor of Mechanical and Aeronautical Engineering, Purdue University, Lafayette, Ind. 1943
FREDERICK, MICHAEL, Assistant Professor of Civil Engineering, Newark College of Engineering, Newark N. J. 1943
FREEL, WILFRED I., Assistant Professor of Civil Engineering, Purdue University, Lafayette, Ind. In military service 1928
FREEMAN, E. H., Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1909
FREEMAN, MATHEW L., Professor and Head, Department of Drawing, Mississippi State College, State College, Miss. 1928
FRENCH, ARTHUR W., Professor Emeritus of Civil Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1900
FRENCH, ORVAL C., Assistant Agricultural Engineer, Radiation Lab., University of California, Berkeley, Calif. 1940
FREUD, B. B., Professor and Chairman, Dept. of Chemistry, Illinois Institute of Technology, Chicago, Ill. 1934
FREUND, C. J., Dean, College of Engineering, University of Detroit, Detroit, Mich. (*Member of Council, 1941–4.*) 1932
FRIEDRICH, LAWRENCE M., Associate Professor of Civil Engineering, University of Toledo, Toledo, Ohio 1938
FRIGON, AUGUSTIN, President, Ecole Polytechnique, Montreal, Canada. (*Member of Council, 1930–33.*) 1929
FRIGON, RAYMOND A., Instructor in Mechanical Engineering, Ecole Polytechnique, Montreal, Canada 1942
FROCHT, MAX M., Associate Professor of Mechanics, Carnegie Institute of Technology, Pittsburgh, Pa. 1928
FROST, DANIEL C., Assistant Professor in charge of Schedules, Newark College of Engineering, Newark, N. J. R. F. D. 6, Long Lane, Lancaster, Pa. 1936
FRY, HOWARD M., Chairman, Dept. of Physics and Electricity, Franklin and Marshall College, Lancaster, Pa. 1925
FRY, HORACE P., Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. 1914
FRY, THORNTON C., Director of Switching Research, Bell Telephone Laboratories, Inc., 463 West Street, New York City 1929
FRYE, JOHN H., Associate Professor of Metallurgical Engineering, Lehigh University, Bethlehem, Pa. 1943
FULLAN, M. T., Professor and Head, Dept. of Machine Design and Mechanical Drawing, Alabama Polytechnic Institute, Auburn, Ala. 1915
FULLER, A. H., Professor of Civil Engineering, The Iowa State College, Ames, Iowa. (*Member of Council, 1914–7.*) 1901
FULLER, C. E., Professor Emeritus, Dean of Army Students, Massachusetts Institute of Technology, Cambridge, Mass. 1907
FULLER, LEONARD F., Professor of Electrical Engineering and Chairman of Dept., University of California, Berkeley, Calif. 1930

FULLERTON, HERBERT P., Associate Professor of Engineering, University of Buffalo, Buffalo, N. Y. 1942
FURIA, JOHN J., Director, Bureau of Training, Civil Service Commission, New York City 1919
FURNAS, C. C., Director of Research, Curtiss-Wright Laboratory, Buffalo, N. Y. 1935
FURRY, WARREN G., Designer, Dept. of Engineering, Lockheed Aircraft Corp., 1416 Lee Drive, Glendale, Calif. 1944
GABA, MEYER G., Professor of Mathematics, University of Nebraska, Lincoln, Nebr. 1940
GAFFNEY, BERNARD J., Chemical Engineer, U. S. Industrial Chemicals, Inc., New York, N. Y. 1941
GAFFORD, B. NEWMAN, Professor of Electrical Engineering, University of Texas, Austin, Texas 1938
GAGER, FRANK M., Special Research Associate, Harvard University, Cambridge, Mass. 1935
GALBRAITH, RALPH A., Associate Professor of Electrical Engineering, University of Texas, Austin, Texas 1939
GALL, WILLIAM R., Assistant Professor of Mechanical Engineering, University of Louisville, Louisville, Ky. 1941
GALLAGHER, ROBERT T., Assistant Professor of Mining Engineering, Lehigh University, Bethlehem, Pa. 1943
GALLALEE, JOHN M., Professor and Head, Dept. of Mechanical Engineering, University of Alabama, University, Ala. 1930
GALLEN, JOHN J., Assistant Professor of Civil Engineering, Villanova College, Villanova, Pa. 1940
GALLOGLY, HARRY P., Associate Professor of Civil Engineering, Catholic University of America, Washington, D. C. 1943
GAMBLE, WILLIAM H., Professor and Head, Dept. of Electrical Engineering, South Dakota State College, Brookings, S. D. 1931
GANONG, WARREN L., Instructor in Industrial Engineering, Northeastern University, Boston, Mass. 1942
GANT, EDWARD V., Assistant Professor of Civil Engineering, University of Connecticut, Storrs, Conn. 1943
GARBER, HAROLD J., Assistant Professor of Chemical Engineering, University of Cincinnati, Cincinnati, Ohio 1943
GARD, CHARLES M., Assistant Professor of Sanitary Engineering, New York University, New York City. (R. F. D. 3, Poughkeepsie, N. Y.) 1943
GARDNER, HOWARD S., Associate Professor of Chemical Engineering, University of Rochester, Rochester, N. Y. 1938
GARDNER, ROBERT A., Hydraulic Engineer, Bureau of Encroachment, Pa. Dept. of Forests and Waters, Harrisburg, Pa. 1930
GARMAN, WARREN D., Associate Professor of Mechanical Engineering, Bucknell University, Lewisburg, Pa. 1935
GARNER, CLEMENT L., Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, Washington, D. C. 1938
GARRAHAN, CHARLES J., Assistant Professor of Electrical Engineering, Swarthmore College, Swarthmore, Pa. 1941
GARRAN, FRANK W., Professor of Civil Engineering, Dean, Thayer school of Engineering, Dartmouth College, Hanover, N. H. (*Member of Council, 1944–47.*) 1925
GARRELTS, JEWELL M., Associate Professor of Civil Engineering, Columbia University, New York City 1935
GARRETT, SEYMOUR S., Professor of Industrial Economics, Cornell University, Ithaca, N. Y. 1922

GATCOMBE, ERNEST K., Assistant to Chief Engineer, Jackson & Moreland Engineers, Boston, Mass. 1942
GATJE, GEORGE H., Superintendent of Schools, Bay Shore Public Schools, 32 West Lane, Bay Shore, N. Y. 1943
GATLEY, EDW. R., Instructor in Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1943
GAUDEFROY, HENRI, Assistant to the Dean and Registrar, Ecole Polytechnique, Montreal, Canada 1942
GAUDIN, ANTOINE M., Richards Professor of Mineral Dressing, Massachusetts Institute of Technology, Cambridge, Mass. 1941
GAULT, ARTHUR E., Dean, Arts and Science, Professor of Mathematics, Bradley Polytechnic Institute, Peoria, Ill. 1939
GAUM, CARL G., Professor of University Extension, Rutgers University, New Brunswick, N. J. 1928
GAUSS, HENRY F., Head, Dept. of Mechanical Engineering, University of Idaho, Moscow, Ida. 1926
GAY, HAROLD J., Professor of Mathematics, Worcester Polytechnic Institute, Worcester, Mass. 1930
GAYLORD, CHARLES N., Assistant Professor of Engineering Mechanics, North Carolina State College, Raleigh, N. C. 1937
GAYLORD, EDWIN H., Associate Professor of Civil Engineering, The Ohio University, Athens, Ohio 1936
GEER, ROGER L., Assistant Professor of Materials Processing, Cornell University, Ithaca, N. Y. 1942
GEHMAN, HARRY M., Professor of Mathematics, University of Buffalo, Buffalo, N. Y. 1941
GEHRIG, ARTHUR G., Assistant Professor of Civil Engineering, Pasadena Junior College, Pasadena, Calif. 1929
GEIGER, JOHN W., Assistant Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1923
GELOTTE, Ernest N., Associate Professor of Architecture, Massachusetts Institute of Technology, Cambridge, Mass. 1943
GEORGE, VINCENT C., Lecturer in Mechanical Engineering, University of Southern California, Los Angeles, Calif. 1931
GERARDI, JASPER, Associate Professor and Director of Engineering Drawing, University of Detroit, Detroit, Mich. 1929
GERHARDT, HERMAN O., Architectural Engineer, Chicago, Ill. 1944
GERHARDT, ROYAL M., Assistant Dean, School of Engineering, Professor of Architectural Engineering, The Pennsylvania State College, State College, Pa. 1944
GERTZ, FRED H., Assistant Professor and Head, Dept. of English, Pratt Institute, Brooklyn, N. Y. 1939
GETCHELL, EDWARD L., Professor of Mechanical Engineering, University of New Hampshire, Durham, N. H. 1921
GEYER, JOHN C., Associate in Civil Engineering, Johns Hopkins University, Baltimore, Md. 1931
GIANNINI, MARIO C., Associate Professor of Mechanical Engineering, New York University, New York, N. Y. 1935
GIBBS, RUSSELL E., Professor and Head, Dept. of Mechanical Engineering, Montana State College, Bozeman, Mont. 1931
GIBSON, GEORGE, Assistant Professor of Chemistry, Illinois Institute of Technology, Chicago, Ill. 1942
GIESE, HENRY, Professor of Agricultural Engineering, Iowa State College, Ames, Iowa 1944

GIESECKE, F. E., Professor Emeritus, Texas A. & M. College, College Station, Texas. (*Member of Council, 1921–4.*) 1893
GIESY, PAUL M., Professor of Chemical Engineering, Newark College of Engineering, Newark, N. J. 1932
GIFFT, HOWARD M., Associate Professor of Civil Engineering, Cornell University, Ithaca, N. Y. 1941
GILBERT, WILLIAM W., Associate Professor of Metal Processing, University of Michigan, Ann Arbor, Mich. 1940
GILBRETH, LILLIAN M., Professor of General Engineering, Purdue University; 30 The Crescent, Montclair, N. J. 1938
GILCHRIST, GIBB, President, A. & M. College of Texas, College Station, Texas 1937
GILES, RANALD V., Associate Professor of Civil Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937
GILKEY, HERBERT J., Professor and Head, Department of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa. (*Vice President, 1943–44; Member of Council, 1936–39.*) 1922
GILLAN, GERALD K., Instructor in Civil Engineering, University of Missouri, Columbia, Mo. 1941
GILMOUR, WALTER A., 1271 Collinwood Ave., Akron, O. 1922
GILPIN, CHARLES A., Assistant Professor of Mechanical Engineering, University of North Dakota, Grand Forks, N. D. 1941
GINGRICH, R. F., Associate Professor of Engineering Drawing, Kansas State College, Manhattan, Kans. 1932
GIRVIN, HARVEY F., Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. 1927
GJESDAHL, MAURICE S., Research Engineer, Landis Tool Co., Waynesboro, Pa. 1938
GLASGOW, ROY S., Professor and Chairman, Dept. of Electrical Engineering, Washington University, St. Louis, Mo. **In military service** 1939
GLEASON, JAMES G., Assistant Professor of Mechanical Engineering, University of Arkansas, Fayetteville, Ark. 1940
GLEASON, MABEL R., Librarian, Stromberg-Carlson Co., Rochester, N. Y. 1944
GLEESON, GEORGE W., Acting Dean, Oregon State College, Corvallis, Ore. 1939
GLENDINNING, WILLIAM, Assistant Supervisor of Training, Consolidated Edison Co. of N. Y., 4 Irving Place, New York City 1937
GLENN, HOWARD E., Associate Professor of Civil Engineering, Clemson Agricultural College, Clemson, S. C. 1939
GLENN, KARL B., Assistant Professor of Electrical Engineering, North Carolina State College, Raleigh, N. C. 1937
GLENN, WM. DAVID, Associate Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn. 1944
GODDARD, EARL G., Instructor in Electrical Engineering, The Rice Institute, Houston, Texas. **In military service** 1941
GODEKE, HARRY F., Professor and Head, Dept. of Mechanical Engineering, Texas Technological College, Lubbock, Texas 1930
GODIN, CAMILLE R., Assistant Professor of Mathematics, Ecole Polytechnique, Montreal, Canada 1944
GODFREY, WILLIAM P., Assistant Professor of English, University of Detroit, Detroit, Mich. **In military service** 1929
GOFF, JOHN A., Dean, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa. 1938
GOGLIA, MARIO J., Associate in Mechanical Engineering, University of Illinois, Urbana, Ill. 1940

GOLDSMITH, ARTHUR, 519 Cornelia Ave., Chicago 13, Ill. **In military service.** 1939
GOMBERG, HENRY J., Instructor in Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1943
GONZALEZ, ORLANDO, 330 S. Sacramento Blvd., Chicago 12, Ill. 1943
GOOD, ADELBERT C., Assistant Professor of Engineering Shops, Wayne University, Detroit, Mich. 1943
GOOD, B. MERRILL, Professor and Head, Dept. of Industrial Engineering, Montana State College, Bozeman, Mont. 1933
GOODALE, STEPHEN L., Professor of Metallurgical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1941
GOODE, HENRY P., Assistant Professor of Mechanical Engineering, Stanford University, Stanford University, Calif. 1943
GOODHEART, CLARENCE F., Instructor in Electrical Engineering, A. & M. College of Texas, College Station, Texas. **In military service** 1939
GOODHEART, EDMUND J., Professor and Head, Mathematics Dept., North Texas Agricultural College, Arlington, Texas. **In military service** 1937
GOODIER, JAMES N., Professor of Mechanics, Cornell University, Ithaca, N. Y. 1941
GOODMAN, WILLIAM, Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. 1944
GOODRICH, RALPH D., Dean, College of Engineering, University of Wyoming, Laramie, Wyo. 1929
GORDER, LESLIE O., Professor of Radio, Chicago Technical College, Chicago, Ill. 1943
GORHAM, ROBERT C., Associate Professor of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1925
GORMAN, WM. M., Instructor in Mechanical Engineering, Villanova College, Villanova, Pa. 1940
GOSSARD, MYRON L., 40 No. Theorunda Dr., Cheektowaga, N. Y. 1939
GOTAAS, HAROLD B., Professor of Sanitary Engineering, University of North Carolina, Chapel Hill, N. C. **In military service** 1932
GOUGH, ACHILLES C., Professor of Mechanical Engineering, Director of Division, University of Idaho, Southern Branch, Pocatella, Ida. 1922
GOULD, JAY R., Assistant Professor of English, Rensselaer Polytechnic Institute, Troy, N. Y. 1941
GOVIER, CHARLES E., Professor of Electrical Engineering, Pennsylvania State College, State College, Pa. 1930
GOWDY, ROBERT C., Dean, College of Engineering and Commerce, University of Cincinnati, Cincinnati, Ohio 1942
GOWER, ALBERT H., Assistant Professor of Chemical Engineering, Michigan State College, East Lansing, Mich. 1939
GRACE, CHARLES T., Assistant Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1942
GRAF, SAMUEL H., Professor and Head, Dept. of Mechanical Engineering, Director of Engineering Research, Oregon State College, Corvallis, Ore. 1940
GRAHAM, JAMES H., Dean, College of Engineering, University of Kentucky, Lexington, Ky. 1935
GRAHAM, WALTER W., Assistant Professor of Mathematics, Vanderbilt University, Nashville, Tenn. 1939
GRAM, LEWIS M., Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1913

GRAMMER, FRANK A., Associate Professor of English, Newark College of Engineering, Newark, N. J. 1943
GRAMSTORFF, EMIL A., Professor and Head, Dept. of Civil Engineering, Northeastern University, Boston, Mass. 1926
GRANDI, LOUIS L., Associate Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1937
GRANEY, MAURICE R., Assistant Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1943
GRANGER, ARMOUR T., Professor and Head, Dept. of Civil Engineering, University of Tennessee, Knoxville, Tenn. 1939
GRANT, EUGENE L., Professor of Economics of Engineering, Stanford University, Stanford University, Calif. 1925
GRANT, HIRAM E., Assistant Professor of Drawing, University of Wisconsin, Milwaukee, Wis. 1937
GRANTHAM, GUY E., Professor of Physics, Cornell University, Ithaca, N. Y. 1928
GRASSO, SALVATORE, Tutor in Civil Engineering, College of the City of New York, New York City 1939
GRAVES, HAROLD E., Professor of Chemical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1940
GRAVES, HARRY P., Manager, College Dept., McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. 1944
GRAVES, QUINTIN B., Assistant Professor of Civil Engineering, University of Texas, Austin, Texas 1939
GRAWE, OLIVER R., Associate Professor of Geology, Missouri School of Mines, Rolla, Mo. 1944
GRAY, ELLSWORTH S., Professor and Head, Dept. of Mechanical Engineering, University of Kansas, Lawrence, Kans. 1931
GRAY, GEORGE H., Transmission Engineer, International Tel. & Tel. Corp., New York City 1942
GRAY, HAMILTON, Assistant Professor of Civil Engineering, New York University, New York City 1940
GRAY, HENRY C., Falk Corp., 1717 E. Kane Place, Milwaukee 2, Wis. ... 1929
GRAY, JOHN C., Professor of Chemistry, U. S. Naval Academy, Annapolis, Md. 1920
GRAY, TRUMAN S., Associate Professor of Engineering Electronics, Massachusetts Institute of Technology, Cambridge, Mass. 1939
GRAY, WILLARD F., Associate Professor of Electrical Engineering, Texas Technological College, Lubbock, Texas 1938
GREAVES-WALKER, A. F., Professor and Head, Dept. of Ceramic Engineering, North Carolina State College, Raleigh, N. C. (*Member of Council, 1944–47.*) 1925
GREEN, BOYNTON M., Professor of Mechanical Engineering, Stanford University, Stanford University, Calif. **In military service** 1925
GREEN, ROY C., Naval Ordnance Lab., Washington Navy Yard, 410 A St., S.E., Washington, D. C. 1940
GREEN, ROY M., Professor and Chairman, Dept. of Civil Engineering, University of Nebraska, Lincoln, Nebr. 1940
GREEN, WILSON P., Associate Professor of Mechanical Engineering, University of Maryland, College Park, Md. 1940
GREENE, ARTHUR M., JR., Dean Emeritus, School of Engineering, Princeton University, Princeton, N. J. (*President, 1919–20; Member of Council, 1906–9; 1914–.*) 1903
GREENE, JOHN W., Professor and Head, Dept. of Chemical Engineering, Kansas State College, Manhattan, Kans. 1939

GREENSTEIN, PHILIP, Assistant Professor of Electrical Engineering, New York University, New York City 1938
GREENWALD, DAKOTA U., Assistant Professor of Mechanical Engineering, University of Delaware, Newark, Del. 1938
GREENWOOD, ERNEST J. A., Project Engineer, Chance Vought Aircraft Div., United Aircraft Corp., Stratford, Conn. 1943
GREENWOOD, JOHN W., Instructor in Engineering, University of Buffalo, Buffalo, N. Y. 1944
GREFFE, C. DALE, Associate in Mechanical Engineering, University of Illinois, Urbana, Ill. 1940
GREGORY, CHARLES A., Visiting Professor of Electrical Engineering, Cambridge, Mass. 1942
GREGORY, FRANCIS A., Principal, Armstrong Technical High School, Washington, D. C. 1944
GREINER, OTTO A., Associate Professor of Modern Languages, Purdue University, Lafayette, Ind. 1922
GREVE, F. W., Professor of C.E., E.M., Purdue University, Lafayette, Ind. 1912
GREYSON, JOSEPH C., Instructor in Mechanical Engineering, Villanova College, Villanova, Pa. 1943
GRIDER, RICHARD L., Associate Professor of Mining Engineering and Drawing, University of Kansas, Lawrence, Kans. 1922
GRIFFIN, FRED S., Professor of Mechanical Engineering, University of Akron, Akron, O. 1922
GRIFFIS, LE VAN, Associate Professor of Mechanics, Illinois Institute of Technology, Chicago, Ill. 1944
GRIFFITH, D. M., Professor and Chairman, Dept. of Civil Engineering, Bucknell University, Lewisburg, Pa. 1924
GRIFFITH, RUSSELL T., Instructor in Chemical Engineering, Illinois Institute of Technology, Chicago, Ill. 1942
GRINTER, LINTON E., Vice President, Dean, Graduate School, Illinois Institute of Technology, Chicago, Ill. (*Member of Council, 1935–8.*) 1928
GRISET, HENRY E., Instructor in Civil Engineering, College of the City of New York, New York, N. Y. 1942
GRISWOLD, EDWARD M., Instructor in Machine Design and Engineering Drawing, The Cooper Union, New York City 1941
GRONE, EDWIN A., Associate Professor of Engineering Mechanics, University of Nebraska, Lincoln, Nebr. 1938
GROSECLOSE, FRANK F., Professor of Industrial Engineering, Director of Cooperative Plan, North Carolina State College, Raleigh, N. C. **In military service** 1937
GROSS, ERIC T. B., Assistant Professor of Electrical Engineering, Cornell University, Ithaca, N. Y. 1942
GROSS, HOWARD W., Dean, Spring Garden Institute, Broad and Spring Garden Streets, Philadelphia, Pa. 1944
GROSSER, CHRISTIAN E., Standard Machinery Co., Providence 7, R. I. 1940
GROSSER, WILFRED R., Instructor in Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1941
GUDEBSKI, HENRY C., Instructor in Metallurgy, University of Detroit, Detroit, Mich. 1942
GUELPA, LEO B., Lt. U.S.N.R., Associate Educational Officer, Mathematics, and Research, U. S. Merchant Marine Cadet Corps, 10 Welwyn Road, Great Neck, N. Y. 1944
GUERDAN, GEORGE A., Assistant Professor of Mechanical Engineering, College of the City of New York, New York City 1938

GUERNSEY, ROSCOE, Assistant Professor of Civil Engineering, University of Texas, Austin, Texas 1941
GUEST, CHARLES B., Professor and Chairman, Dept. of English, Missouri School of Mines, Rolla, Mo. 1944
GUILD, LAWRENCE R., Professor and Head, Dept. of Management Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1932
GUILLEMIN, ERNST A., Professor of Electrical Communications, Massachusetts Institute of Technology, Cambridge, Mass. 1944
GULLIKSON, ALBERT C., Instructor in General Engineering, University of Washington, Seattle, Wash. 1943
GUNDER, D. F., Associate Professor of Mathematics and Civil Engineering, Colorado State College, Ft. Collins, Colo. 1938
GURNEY, GORDON T., Instructor in Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1943
GUS, CHARLES E., Executive Secretary, College of Engineering, Professor of Engineering Mechanics, New York University, New York City .. 1926
GUSE, CLARENCE E. 1933
GUTHRIE, ALBERT N., Assistant Professor of Physics, Brooklyn College, Brooklyn, 10, N. Y. 1937
GUTHRIE, LEDRU O., Instructor in English, University of Minnesota, Minneapolis, Minn. 1938
GWINN, IRA J., Assistant Professor of Physics and Pre-Engineering, Morningside College, Sioux City, Iowa 1934
HAAS, MATTHIAS E., Dean of Engineering, Professor of Chemical Engineering, University of Dayton, Dayton, Ohio 1935
HACHEMEISTER, CHARLES A., Instructor in Drafting, College of the City of New York, New York City 1940
HAENISCH, EDWARD L., Professor of Chemistry and Chemical Engineering, Villanova College, Villanova, Pa. 1937
HAENTJENS, CHARLES H., Instructor in Drawing and Mathematics, Santa Rosa Junior College, Santa Rosa, Calif. 1939
HAERTLEIN, ALBERT, Gordon McKay Professor of Civil Engineering, Harvard University, Cambridge, Mass. 1929
HAINES, D. DON, Associate Professor of Civil Engineering, University of Kansas, Lawrence, Kansas 1935
HALES, VIRGIL D., Assistant Professor and Head, Dept. of Engineering Drawing, Fenn College, Cleveland, Ohio 1930
HALL, ALLEN S., Instructor in Mechanical Engineering, Purdue University, Lafayette, Ind. 1944
HALL, AMY V., Assistant Professor of English, University of Washington, Seattle, Wash. 1925
HALL, CLARENCE A., Research Engineer, Ethyl Corp., 1600 W. 8 Mile Rd., Detroit, Mich. 1939
HALL, PHILIP R., Associate Professor of Industrial Engineering, The Pennsylvania State College, State College, Pa. 1938
HALL, RUSSELL A., 124 N. Lane St., Blissfield, Mich. 1925
HALL, STANLEY G., Assistant Professor of General Engineering Drawing. University of Illinois, Urbana, Ill. 1938
HALL, STANLEY R., Senior Design Engineer, Lockheed Aircraft Corp., Burbank, Calif. 1936
HALL, VORIS B., Associate Professor of Physics, Bucknell University Junior College, 158 So. Washington St., Wilkes Barre, Pa. 1927
HALL, WESLEY B., Professor and Head, Dept. of Electrical Engineering, Rhode Island State College, Kingston, R. I. **In military service** .. 1925

HALL, WILLIAM H., Dean, College of Engineering, Duke University, Durham, N. C. 1927
HALLER, GEORGE L., Chief, Research Division, Aircraft Radio Laboratory, Wright Field, Dayton, Ohio 1944
HALLIDAY, WILLIAM R., Professor of Machine Design, Stevens Institute of Technology, Hoboken, N. J. 1926
HALSEY, HUGH, Instructor in Physics, Cooper Union, New York City 1933
HAM, C. W., Professor of Machine Design, University of Illinois, Urbana, Ill. 1933
HAMILTON, EDW. P., President, John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1914
HAMILTON, ERWIN H., Associate Professor of Automotive Engineering, New York University, New York City 1938
HAMLIN, EDWIN W., Professor of Electrical Engineering, University of Texas, Austin, Texas 1935
HAMMOND, H. P., Dean, School of Engineering, The Pennsylvania State College, State College, Pa. (*Director of Summer Schools for Engineering Teachers, 1927–33; Associate Director of Investigations, 1923–29; Member of Council, 1927–30, 1936–; Vice President, 1934–35; President, 1936–37.*) 1916
HAMMOND, THOMAS M., Head, Dept. of Engineering and Physics, Schreiner Institute, Kerrville, Texas 1940
HAMMONS, WILLIAM M., Assistant to the Dean, University of Louisville, Louisville, Ky. 1943
HANEY, JILES W., Professor and Chairman, Department of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. In military service .. 1916
HANEY, PAUL D., Chief Engineer, Div. of Sanitation, University of Kansas, Lawrence, Kans. 1940
HANNUM, JOSHUA E., Assistant Dean of Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1935
HANRAHAN, FRANCIS J., Structural Engineer, National Lumber Mfg. Assoc., 6220 Wagner Lane, Bethesda, Md. 1936
HANSELMAN, FRED P., Assistant Professor of English, Michigan College of M. & T., Houghton, Mich. 1943
HANSELMAN, GEORGE R., Associate Professor of Administrative Engineering, Cornell University, Ithaca, N. Y. 1938
HANSEN, WALTER E., Instructor in General Engineering Drawing, University of Illinois, Urbana, Ill. 1943
HANSON, ARNOLD E., Associate Professor of Industrial Education, University of New Hampshire, Durham, N. H. 1944
HANSON, KARL P., Professor and Head, Dept. of Mechanical Engineering, University of Connecticut, Storrs, Conn. 1941
HANSON, ROBERT S., Associate Professor of Chemistry, Drexel Institute of Technology, Philadelphia, Pa. 1936
HANSON, THOMAS C., Assistant Professor and Acting Head, Dept. of Civil Engineering, University of Detroit, Detroit, Mich. 1941
HANSTEIN, HENRY B., Assistant Professor of Electrical Engineering, College of the City of New York, New York City 1938
HARDER, OSCAR E., Assistant Director, Battelle Memorial Institute, Columbus, Ohio 1925
HARDGRAVE, JOHN C., Associate Professor of Mechanical Engineering, Texas Technological College, Lubbock, Texas 1930
HARDING, GEORGE H., Assistant Professor of Civil Engineering, University of Louisville, Louisville, Ky. In military service 1930

HARGIS, ANDREW B., Dean, School of Engineering, University of Mississippi, University, Miss. 1937
HARKNESS, DANIEL H., Sales Engineer, W. & L. E. Gurley Co., Troy, N. Y. 1928
HARLOW, HENRY G., Assistant Professor of Civil Engineering, Union College, Schenectady, N. Y. 1942
HARMAN, CAMERON G., Assistant Professor of Ceramic Engineering, University of Illinois, Urbana, Ill. 1943
HARNESS, GEORGE T., Assistant Professor of Electrical Engineering, Columbia University, New York City 1941
HARPER, A. C., President, Wyomissing Polytechnic Institute, Wyomissing, Pa. 1911
HARPER, SAM M., Principal, Metropolitan Technical School, 260 W. 41st St., New York City 1943
HARRELSON, JOHN W., Dean of Administration, North Carolina State College, Raleigh, N. C. 1933
HARRINGTON, JOHN M., Professor of Mathematics, Michigan College of M. & T., Houghton, Mich. 1943
HARRINGTON, LOUIS C., Dean, College of Engineering, University of North Dakota, Grand Forks, N. D. 1936
HARRINGTON, ROBERT L., Instructor in Mechanical Engineering, Tufts College, Medford, Mass. 1941
HARRINGTON, RUSSELL P., Professor and Head, Dept. of Aeronautical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1942
HARRIS, BOYD T., College Representative, The Macmillan Co., 60 Fifth Avenue, New York City 1943
HARRIS, CHARLES O., Associate Professor of Mechanics, Illinois Institute of Technology, Chicago, Ill. 1939
HARRIS, ERNEST C., Instructor in Structural Engineering, Fenn College, Cleveland, Ohio 1942
HARRIS, HARRY E., Consulting Engineer, 229 Thorme St., Bridgeport, Conn. 1924
HARRIS, HENRY E., Visiting Lecturer, Oberlin College, Oberlin, Ohio 1943
HARRIS, L. DALE, Assistant Professor of Electrical Engineering, University of Utah, Salt Lake City, Utah 1943
HARRIS, WALTER R., Industry Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1944
HARRISON, ED. M., Coördinator, School of Engineering, Southern Methodist University, Dallas, Texas 1939
HARRISON, THOMAS P., Dean, Emeritus, North Carolina State College, Raleigh, N. C. 1942
HART, SIMEON T., Professor and Head, Dept. of Administrative Engineering, Syracuse University, Syracuse, N. Y. 1941
HART, STEPHEN V., Assistant Professor of Electrical Engineering, Swarthmore College, Swarthmore, Pa. 1943
HARTENBERG, RICHARD S., Assistant Professor of Mechanics, Northwestern Technological Institute, Evanston, Ill. 1930
HARTIG, HENRY E., Professor of Communication Engineering, University of Minnesota, Minneapolis, Minn. 1922
HARTLEY, LODWICK C., Professor and Head, Dept. of English, North Carolina State College, Raleign, N. C. In military service 1940
HARTMAN, PAUL, Instructor in Civil Engineering, College of the City of New York, New York City. In military service 1940
HARTSOOK, ARTHUR J., Professor and Head, Division of Chemical Engineering, Rice Institute, Houston, Texas 1938

HASKINS, ELMER E., Associate Professor of Mathematics, Northeastern University, Boston, Mass. 1932
HASKINS, GEORGE W., Major, Headquarters ATC, Washington, D. C..... 1940
HASTINGS, HUDSON B., Professor of Economics, Yale University, New Haven, Conn. 1928
HATCH, WM. ERNEST, Instructor in Civil Engineering, Massachusetts Maritime Academy, Hyannis, Mass. 1939
HATCHER, THOMAS W., Professor of Mathematics, Virginia Polytechnic Institute, Blacksburg, Va. 1935
HATHAWAY, ARTHUR S., Assistant Professor of Surveying and Drawing, Northwestern University, Evanston, Ill. 1934
HATTRUP, HUBERT E., Instructor in Electrical Engineering, University of Idaho, Moscow, Ida. 1941
HAUPT, LEWIS M., Acting Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1937
HAUSER, ERNST A., Associate Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943
HAUSMANN, ERICH, Registrar and Dean of the College, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1926
HAWKES, JOHN B., Associate Professor of Physics, Stevens Institute of Technology, Hoboken, N. J. 1939
HAWKINS, GEORGE A., Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1930
HAWKINS, ROBERT D., Professor of Applied Mechanics, University of Kentucky, Lexington, Ky. 1939
HAWLEY, RANSOM S., Professor and Chairman, Dept. of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1940
HAWN, HERBERT W., Assistant Professor of Mechanical Engineering, Michigan College of M. & T., Houghton, Mich. 1944
HAY, EARL D., Professor of Mechanical and Industrial Engineering, University of Kansas, Lawrence, Kans. 1915
HAYNES, HAROLD A., Principal, Dunbar High School, Washington, D. C. 1942
HAYNES, HILLIARD G., Associate Professor of Civil Engineering, The Citadel, Charleston, S. C. 1936
HAYS, FRANK B., M. I. T., Cambridge, Mass. **In military service** 1939
HAYWARD, HAROLD N., Assistant Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1936
HAZELL, WILLIAM, Assistant Professor of Physics, Newark College of Engineering, Newark, N. J. 1943
HAZELTINE, ALAN, 15 Tower Drive, Maplewood, N. J. 1910
HAZEN, HAROLD L., Professor and Head, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1938
HAZEN, JOHN W., Assistant Chief Engineer, Lear Avia of Calif., Inc., Los Angeles, Calif. 1932
HAZEN, LESLIE E., Professor and Head, Dept. of Agricultural Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1940
HEACOCK, FRANK A., Head, Dept. of Graphics and Engineering Drawing, Princeton University, Princeton, N. J. 1926
HEALD, HENRY T., President, Illinois Institute of Technology, Chicago, Ill. (*President, 1942–43; Vice President, 1941–2; Member of Council, 1938–.*) 1931
HEANY, ARTHUR G., Manager, Text-Book Dept., D. Van Nostrand Company, 250 4th Avenue, New York, N. Y. 1929
HEARD, M. EARL, Director of Research, West Point Mfg. Co., Shawmut, Ala. 1935

HEATH, CHARLES O., Instructor in Mechanical Engineering, Rutgers University, New Brunswick, N. J. 1942
HEATH, EDWARD B., Associate Professor, San Bernardino Valley Junior College, San Bernardino, Calif. **In military service** 1935
HEBRANK, EUGENE F., Instructor in Marine Engineering, U. S. Naval Academy, Annapolis, Md. 1940
HEDENBERG, NORMAN A., Instructor in Physics, Wilbur Wright Junior College, 4261 W. Wareland Ave., Chicago 41, Ill. 1939
HEFFNER, ROY J., Assistant Personnel Director, Bell Telephone Laboratories, 463 West Street, New York, N. Y. 1930
HEIL, LOUIS M., Professor and Head, Dept. of Physics, Cooper Union, New York City 1943
HEIN, JAMES M., Associate Professor and Head, Dept. of Engineering Drawing, University of North Dakota, Grand Forks, N. D. 1940
HELANDER, LINN, Professor and Head, Department of Mechanical Engineering, Kansas State College, Manhattan, Kansas 1935
HELLER, RALPH, Instructor in Physics, Worcester Polytechnic Institute, Worcester, Mass. 1943
HELWIG, CARL E., Lecturer in Civil Engineering, University of Toronto, Toronto, Ont. 1943
HEM, LAWRENCE W., Instructor in Mechanical Engineering, College of the City of New York, New York City. **In military service** 1939
HEMKE, PAUL E., Head, Dept. of Aeronautical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1943
HEMPSTEAD, JEAN C., Associate Professor of General Engineering, Iowa State College, Ames, Iowa. **In military service** 1935
HENDERSON, FREDERICK R., Acting Head, Dept. of Industrial Engineering, Assistant Dean, Northeastern University, Boston, Mass. **In military service** 1940
HENDERSON, JAMES M., Director, Department of Industrial Arts, Professor of Civil Engineering, Tennessee Polytechnic Institute, Cookeville, Tenn. 1930
HENDRICKS, WALTER, Professor and Head, Department of English and Modern Language, Illinois Institute of Technology, Chicago, Ill. 1933
HENIKA, JOHN H., Foreman, Wood Laboratory, Georgia School of Technology, Atlanta, Ga. 1936
HENLINE, HENRY H., National Secretary, American Institute of Electrical Engineers, 33 W. 39th Street, New York City 1919
HENNES, ROBERT G., Associate Professor of Civil Engineering, University of Washington, Seattle, Wash. 1935
HENNESSY, WESLEY J., Assistant to Dean, Faculty of Engineering, Columbia University, New York City 1943
HENNEY, KEITH, Editor, Electronics, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y. 1942
HENNINGER, G. ROSS, Editor, American Institute of Electrical Engineers, 33 West 39th St., New York City. **In military service** 1940
HENRY, GEORGE F., Associate Professor of Mechanical Engineering, Colorado State College, Ft. Collins, Colo. 1939
HENRY, HERMAN L., Instructor in Technical Drawing, Illinois Institute of Technology, Chicago, Ill. 1942
HENRY, HOWARD J., Instructor in Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1939
HENRY, JOHN A., Associate in Mechanical Engineering, University of Illinois, Urbana, Ill. 1941

HENRY, LEVI L., Professor of Mechanical Engineering, Detroit Institute of Technology, Detroit, Mich. 1944
HENSHAW, CHARLES N., Engineer, Pal Blade Co., Plattsburg, N. Y. 1930
HERMES, RICHARD M., Assistant Professor of Engineering, University of Santa Clara, Santa Clara, Calif. 1943
HERNDON, LYLE K., Associate Professor of Chemical Engineering, The Ohio State University, Columbus, Ohio 1938
HERREMAN, HAROLD M., Assistant Professor of Physics, Fresno State College, Fresno, Calif. 1940
HERRICK, CARL A., Associate Professor of Mathematics and Mechanics, University of Minnesota, Minneapolis, Minn. 1922
HERRICK, THOMAS J., Research Engineer, McDonnell Aircraft Corp., St. Louis, Mo. 1936
HERSHMAN, JOSEPH B., President, Valparaiso Technical Institute, Box 490, Valparaiso, Ind. 1943
HERTEL, KENNETH L., Professor and Head, Dept. of Physics, University of Tennessee, Knoxville, Tenn. 1941
HERTZLER, ELMER A., Director of War Research, United Electronics Co., Newark, N. J. 1929
HESS, HOWARD M., Assistant Professor of Electrical Engineering, Wayne University, Detroit, Mich. 1942
HESS, WENDELL F., Associate Professor and Head of Welding Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y. 1936
HESSE, HERMAN C., Professor of Engineering Drawing, University of Virginia, University, Va. 1929
HESSLER, VICTOR P., Professor and Chairman, Dept. of Electrical Engineering, University of Kansas, Lawrence, Kansas 1928
HETT, JOHN H., Assistant Professor of Physics, Manhattan College, New York City 1939
HETZEL, THEODORE B., Assistant Professor of Mechanical Engineering, Haverford College, Haverford, Pa. 1936
HEWITT, CECIL M., Professor and Head, Dept. of Automobile and Aeronautics, Bradley Polytechnic Institute, Peoria, Ill. 1942
HEYTHUM, ANTONIN, Head, Dept. of Industrial Design, California Institute of Technology, Pasadena, Calif. 1943
HIBBARD, SHELDEN S., Instructor in Drawing, University of Minnesota, General Extension Division at Duluth, Minn. 1943
HIBSHMAN, NELSON S., Dean, School of Science and Technology, Pratt Institute, Brooklyn 5, N. Y. 1930
HICKS, WILLIAM N., Professor and Head, Dept. of Ethics and Religion, North Carolina State College, Raleigh, N. C. 1939
HIGBEE, F. G., Professor and Head, Dept., Engineering Drawing, State University of Iowa, Iowa City, Ia. (*Vice President, 1922–3; Member of Council, 1916–9.*) 1906
HIGBIE, H. H., Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. (*Member of Council, 1929–32.*) 1908
HIGDON, R. ARCHIE, Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa. **In military service** 1938
HIGGINBOTTOM, EDWIN, Professor and Head, Dept. of English, Worcester Polytechnic Institute, Worcester, Mass. 1943
HIGGINS, GEORGE J., Professor and Acting Director of Aeronautical Engineering, University of Detroit, Detroit, Mich. **In military service** 1935
HIGGINS, PAUL R., Assistant Professor of Aeronautical Engineering, A. & M. College of Texas, College Station, Texas 1938

HIGGINS, THOMAS J., Associate Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1940
HILBERRY, H. NORMAN, Assistant Professor of Physics, University of Chicago, Chicago, Ill. 1935
HILDRETH, WILLIAM H., Director of English, The Ohio State University, Columbus, Ohio 1943
HILL, ARTHUR M., Associate Professor of Heat Engineering, Tulane University, New Orleans, La. 1931
HILL, A. S., Professor of Electrical Engineering, University of Maine, Orono, Me. 1919
HILL, FRANCIS M., Associate Professor of Engineering Drawing and Mechanics, Georgia School of Technology, Atlanta, Ga. 1936
HILL, IVAN L., Assistant Professor of Technical Drawing, Illinois Institute of Technology, Chicago, Ill. 1942
HILL, J. LAWRENCE, JR., Associate Professor of Mechanical Engineering, University of Rochester. Rochester, N. Y. 1936
HILL, WM. WELCH, Professor of Electrical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1943
HILLYARD, LAWRENCE R., Assistant Professor of General Engineering, Iowa State College, Ames, Iowa 1940
HILTNER, WALTER F., Instructor in Mechanical Engineering, California Institute of Technology, Pasadena, Calif. 1943
HINCKLEY, A. DEXTER, Executive Secretary, Illuminating Engineering Society, 51 Madison Ave., New York City 10 1929
HINDLE, NORMAN F., Director, Technical Development Program, American Foundrymen's Association, 222 W. Adams St., Chicago, Ill. 1943
HINKLE, ROLLAND T., Assistant Professor of Machine Design, Cornell University Ithaca, N. Y. 1942
HINMAN, JACK, JR., Associate Professor of Sanitation, State University of Iowa, Iowa City, Iowa. **In military service** 1936
HINTON, WILLIAM A., Assistant Professor of Mechanical Engineering, Duke University, Durham, N. C. 1935
HIRST, JOHN M., Instructor in Electrical Engineering, Thayer School of Engineering, Hanover, N. H. 1944
HITCHCOCK, E. A., Dean Emeritus, The Ohio State University, Columbus, O. (*Vice President, 1929–30; Member of Council, 1922–5.*) 1921
HITCHCOCK, LEON W., Professor of Electrical Engineering, Acting Dean, University of New Hampshire, Durham, N. H. 1922
HIXON, CHARLES R., Professor and Head, Dept. of Mechanical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1910
HIXSON. ARTHUR W., Executive Officer, Dept. of Chemical Engineering, Columbia University, New York City 1937
HOADLEY, ANTHONY, Professor of Civil Engineering, Union College, Schenectady, N. Y. 1928
HOADLEY, GEORGE B., Assistant Professor of Graduate Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1935
HOBBS, RANALD P., Manager, Radio and Technical Div., Murray Hill Books, Inc., 232 Madison Ave., New York 16, N. Y. ....
HOBSON, JESSE E., Director, Armour Research Founadtion, Illinois Institute of Technology, Chicago, Ill. 1942
HOCKEMA, FRANK C., Executive Dean, President's Office, Purdue University, Lafayette, Ind. 1921
HODGE, CHARLES A., Head Instructor in Electrical Engineering, Yonkers Technical High School, Yonkers, N. Y. 1932

HODGE, WILLARD W., Professor and Head, Dept. of Chemical Engineering, Director, Engineering Experiment Station, West Virginia University, Morgantown, W. Va. 1930

HODGES, JOHN C., Professor of English, University of Tennessee, Knoxville, Tenn. 1943

HODGINS, LAWRENCE J., Associate Professor of Electrical Engineering, University of Maryland, College Park, Md. 1939

HOEFER, E. G., Professor of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1910

HOELSCHER, RANDOLPH P., Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. (*Member of Council, 1941–4.*) 1912

HOFF, NICHOLAS J., Associate Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1943

HOFFMAN, OSCAR, Associate Professor of Structural Engineering, Fenn College, Cleveland, Ohio 1941

HOFFMAN, P. C., Instructor in Engineering Drawing, University of Detroit, Detroit, Mich. In military service 1939

HOFFMAN, PAUL O., Associate Professor of Mechanics, Newark College of Engineering, Newark, N. J. 1943

HOFMANN, G. A., Professor and Head, Dept. of Mechanical Engineering, University of Dayton, Dayton, O. 1916

HOLBROOK, E. A., Dean, Schools of Engineering and Mines, University of Pittsburgh, Pittsburgh, Pa. (*Member of Council, 1936–39.*) 1927

HOLCOMB, ROBERT M., Designer, Donald R. Warren, Los Angeles; Rt. 5, Box 212, Riverside, Calif. 1938

HOLDREDGE, ERNEST C., Instructor in Mechanical Engineering, University of Tennessee, Knoxville, Tenn. 1943

HOLLAND, A. DINSMORE, Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1933

HOLLAND, LEWIS N., Associate Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1940

HOLLAND, UBERT C., Head, Dept. of General Engineering, Assistant to Dean, Rutgers University, New Brunswick, N. J. 1930

HOLLISTER, S. C., Dean, College of Engineering, Cornell University, Ithaca, N. Y. (*Member of Council, 1937–40*) 1916

HOLLISTER, VERNON L., Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebr. 1940

HOLMAN, LEON W., Instructor in Architectural Engineering, Los Angeles City College, Los Angeles, Calif. 1936

HOLMBERG, CARL H., Assistant Professor of Civil Engineering, Tufts College, Medford, Mass. 1924

HOLME, JUSTUS M., Instructor in Mechanics, U. S. Naval Academy, Annapolis, Md. In military service 1938

HOLME, THOMAS T., Instructor in Mechanical and Industrial Engineering, Lehigh University, Bethlehem, Pa. In military service 1940

HOLMES, ALESTER G., Professor and Head, Dept. of Mechanical Engineering, Mississippi State College, State College, Miss. 1943

HOLMES, CLAYTON W., Associate Professor of Mechanical Engineering, Haverford College, Haverford, Pa. 1933

HOLMES, FRED E., Assistant Professor of Mechanics and Hydraulics, The State University of Iowa, Iowa City, Ia. 1919

HOLMES, LYNN C., Electrical Engineer, Research Dept., Stromberg-Carlson Co., Rochester, N. Y. 1937

HOLMES, MAJOR E., Dean, New York State College of Ceramics at Alfred University, Alfred, N. Y. 1937

HOLMES, WILFRED J., Assistant Professor of Engineering, University of Hawaii, Honolulu, T. H. **In military service** 1937
HOLOWENKO, ALFRED R., Instructor in Mechanical Engineering, Rice Institute, Houston, Texas 1943
HOLT, A. H., Professor and Head, Dept. of Civil Engineering, Worcester Polytechnic Institute, Worcester, Mass. **In military service** 1923
HOLT, CLIFFORD B., JR., Assistant Professor of Electrical Engineering, Pennsylvania State College, State College, Pa. 1933
HOLTBY, FULTON, Assistant Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1941
HONNELL, MARTIAL A., Associate Professor of Electrical Engineering, Georgia School of Technology, Atlanta, Ga. 1943
HONNELL, PIERRE M., Lt. Col., Property Officer, Officer-in-Charge of Laboratories, Dept. Chemistry and Electricity, United States Military Academy, West Point, N. Y. 1943
HONOUR, WILFRED M., Associate Professor of Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1941
HOOD, ARTHUR A., Director of Dealer Relations, Johns-Manville Sales Corp., 22 E. 40th St., New York City 1942
HOOD, GEO. J., Professor of Engineering Drawing, University of Kansas, Lawrence, Kans. 1914
HOOKE, ROBERT, Assistant Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1941
HOOPER, WM. T., Structural Designer, Greeley & Hansen, Chicago, Ill. .. 1940
HOOVER, P. L., Professor of Electrical Engineering, Case School of Applied Science, Cleveland, Ohio 1931
HOPPER, JOHN S., Assistant to Dean of Engineering, A. & M. College of Texas, College Station, Texas 1937
HORACK, CARL W. Chief Engineer, National Motor Bearing Co., Redwood City, Calif. 1933
HORAN, FRANK W., Professor of Civil Engineering, University of Notre Dame, Notre Dame, Ind. 1938
HORN, CIFFORD R., Production Engineer, Panhandle Eastern Pipe Line Co., Kansas City, 6, Mo. 1941
HORN, HARRY W., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. 1938
HOSHALL, HARRY B., Assistant Professor of Mechanical Engineering, University of Maryland, College Park, Md. 1930
HOSTETTER, HARRY C., Assistant Professor of Mathematics, Pratt Institute, Brooklyn, N. Y. 1926
HOTCHKISS, CHARLES H. B., Editor, *Heating and Ventilating*, 148 Lafayette St., New York City 1925
HOTCHKISS, W. O., President Emeritus, Rensselaer Polytechnic Institute; Buckingham Apts., 1-D, Scarsdale, N. Y. 1926
HOTTLE, WARREN M., Instructor in Physics, Pratt Institute, Brooklyn, N. Y. 1938
HOUCHENS, JOHN M., Coördinator, University of Louisville, Louisville, Ky. 1930
HOUGEN, OLAF A., Professor of Chemical Engineering, University of Wisconsin, Madison, Wis. 1930
HOUSEL, WILLIAM S., Associate Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. **In military service** 1938
HOUSER, SHALER C., Treasurer, Professor of Engineering, University of Alabama, University, Ala. 1934

HOUSTON, RAYMOND K., Assistant Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1943
HOVEY, B. K., Instructor in Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1939
HOWARD, DARNLEY E., Associate Professor and Head, Dept. of Mechanical Engineering, Howard University, Washington, D. C. 1928
HOWE, EVERETT D., Assistant Dean of Engineering, University of California, Berkeley, Calif. 1931
HOWE, JEROME W., Dean of Students and Admissions, Worcester Polytechnic Institute, Worcester, Mass. 1925
HOWE, JOSEPH W., Professor and Head, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa 1934
HOWE, LEON B., Professor of Drawing, Syracuse University, Syracuse, N. Y. 1917
HOWELL, ALMONTE C., Professor of English, University of North Carolina, Chapel Hill, N. C. 1943
HOWELL, ALVIN H., Chairman, Dept. of Electrical Engineering, Tufts College, Medford, Mass. 1941
HOWELL, E. J., Registrar, A. & M. College of Texas, College Station, Texas. **In military service** 1937
HOWELL, ERIC V., Associate Professor of Mechanics, Cornell University, Ithaca, N. Y. 1927
HOWES, DOUGLAS E., Professor of Electrical Engineering, Norwich University, Northfield, Vt. 1935
HOWES, HORACE L., Professor of Physics, University of New Hampshire, Durham, N. H. 1943
HOWES, VICTOR E., Instructor in Engineering Drawing, Harvard University, Cambridge, Mass. 1944
HOWEY, JOSEPH H., Professor and Head, Dept. of Physics, Georgia School of Technology, Atlanta, Ga. 1943
HOWLAND, WARREN E., Professor of Sanitary Engineering, Purdue University, Lafayette, Ind. 1926
HOWSON, ELMER T., Vice President, Simmons Boardman Pub. Corp., Western Editor, *Railway Age*, 105 West Adams St., Chicago, Ill. 1939
HOY, ELVIN A., Associate Econ. Statistician, War Production Board, 2800 Erie St., S.E., Washington, D. C. 1930
HOY, HOWARD H., Professor of Engineering Shops, South Dakota State College, Brookings, S. D. 1943
HOYT, CRAIG S., Head, Chemistry, Grove City College, Grove City, Pa. .. 1942
HUBLER, JOHN W., Assistant Professor of Civil Engineering, Washington University, St. Louis, Mo. 1939
HUCKERT, JESSE W., Associate Professor of Mechanical Engineering, University of Maryland, College Park, Md. **In military service** .. 1938
HUCKLE, MYRON S., President, U. S. Diesel Engineering School, 89–91 Brighton Ave., Boston, Mass. **In military service** 1937
HUDEC, EDWARD J. R., Instructor in Industrial Engineering, Case School of Applied Science, Cleveland, Ohio. **In military service** 1943
HUDSON, CHARLES A., Instructor, Radio School, University of Wisconsin, Madison, Wis. **In military service** 1943
HUDSON, PAUL K., Columbia University War Research, New London, Conn. 1942
HUDSON, ROSS C., Associate Professor of Civil Engineering, Clarkson College of Technology, Potsdam, N. Y. 1940
HUGHES, FORREST R., Assistant Professor of Engineering Drawing, Yale University, New Haven, Conn. 1935

HUGHES, GEORGE G., Dean, College of Engineering, Southwestern Louisiana Institute, Lafayette, La. 1924
HUGHES, MARTIN C., Professor and Head, Dept. of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1932
HUGHES, WALTER L., Placement Director, Franklin Technical Institute, Boston, Mass. 1943
HUGO, MERRILL S., Assistant Professor of Mechanical Engineering, Stanford University, Stanford University, Calif. **In military service** .. 1941
HULL, ROBERT H., Associate Professor of Electrical Engineering, University of Utah, Salt Lake City, Utah 1929
HULL, WILLIAM L., Assistant Professor of Mechanical Engineering, University of Colorado, Boulder, Colo. 1940
HUME, ALFRED, Emeritus Chancellor, Head, Mathematics Dept., University of Mississippi, University, Miss. 1894
HUME, WILLIAM, Associate Professor of Civil Engineering, University of New Mexico, Albuquerque, N. M. 1936
HUMMEL, JESSE G., Associate Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1940
HUMMEL, JOSEPH O. P., Management Advisor, W.P.B., Philadelphia, Pa. 1933
HUMMEL, ROLAND L., Graduate Assistant in Civil Engineering, California Institute of Technology, Pasadena, Calif. 1943
HUMPHREY, RICHARD D., Assistant Professor of Humanities, Stevens Institute of Technology, Hoboken, N. J. 1944
HUNDLEY, ROBERT E., Professor of Mechanics, University of Cincinnati, Cincinnati, Ohio 1943
HUNT, DEWITT, Professor and Head, Department of Industrial Arts Education and Engineering Shopwork, Oklahoma A. & M. College, Stillwater, Okla. 1931
HUNT, DONALD C., Instructor in Aeronautical Engineering, University of Detroit, Detroit, Mich. 1941
HUNT, GUY H., Assistant Professor of Applied Mathematics, University of California at Los Angeles, Calif. 1923
HUNT, LOUIS W., Associate Specialist in Engineering Education, U. S. Office of Education, Washington, D. C. 1930
HUNT, MELVIN W., Mechanical Engineer, Dow Styrene Plant, Torrance, Calif. 1918
HUNT, ORVILLE D., Associate Professor of Electrical Engineering, Kansas State College, Manhattan, Kans. (On leave.) 1927
HUNTER, MATTHEW A., Dean of Faculty, Professor and Head, Dept. of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1938
HUNTINGTON, W. C., Professor and Head, Dept. of Civil Engineering, University of Illinois, Urbana, Ill. (*Member of Council, 1929–32.*) 1914
HUNTLEY, PHIL C., Professor and Director of Civil Option, Illinois Institute of Technology, Chicago, Ill. 1938
HURSH, RALPH K., Professor of Ceramic Engineering, University of Illinois, Urbana, Ill. 1943
HURTUBISE, JACQUES E., Assistant Professor of Civil Engineering, Ecole Polytechnique, Montreal, Canada 1942
HUSSEY, ROBERT A., Associate Professor of Industrial Engineering, The Pennsylvania State College, State College, Pa. 1937
HUTCHINS, ROLAND E., Associate Professor of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1936
HUTCHINSON, CHARLES A., Professor and Head, Dept. of Engineernig Mathematics, University of Colorado, Boulder, Colo. 1923

Hutchison, Albert W., Jr., Associate Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn. **In military service** 1934
Hutchisson, Elmer, Dean of the Faculty, Case School of Applied Science, Cleveland, Ohio 1944
Hyde, Emma, Associate Professor of Mathematics, Kansas State College, Manhattan, Kansas 1943
Hyde, Thomas E., Instructor in Engineering, North Carolina State College, Raleigh, N. C. 1941
Hyde, William H., Librarian, College of Engineering, Cornell University, Ithaca, N. Y. 1942
Hydeman, William R., Instructor in Mathematics, U. S. Naval Academy, Annapolis, Md. **In military service** 1941
Hyland, Patrick H., Professor of Machine Design, University of Wisconsin, Madison, Wis. 1943
Hynes, Robert D., Assistant Dean, Evening College, University of Cincinnati, Cincinnati, Ohio 1944
Ingalls, James W., Associate Professor of Industrial Research, Norwich University, Northfield, Vt. 1922
Ingersoll, Leonard R., Professor and Chairman, Dept. of Physics, University of Wisconsin, Madison, Wis. 1941
Ippen, Arthur T., Assistant Professor of Civil Engineering, Lehigh University, Bethlehem, Pa. 1943
Ireson, William G., Associate Professor of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1941
Irland, George A., Professor of Electrical Engineering, Bucknell University, Lewisburg, Pa. 1927
Iversen, Harold W., Instructor in Mechanical Engineering, University of California, Berkeley, Calif. 1943
Jacklin, H. M., Professor of Automotive Engineering, Purdue University, Lafayette, Ind. 1937
Jackson, Dugald C., Professor Emeritus, Massachusetts Institute of Technology, 5 Mercer Circle, Cambridge, Mass. (*President, 1906–7; Member of Council since 1906; Member, Board of Investigation and Coördination, 1922–33.*) **Fourth Recipient Lamme Medal (1931).** 1893
Jackson, Dugald, Jr., Dean, College of Engineering, University of Notre Dame, Notre Dame, Ind. **In military service** 1922
Jackson, Frederick D., Associate Professor of Electrical Engineering, University of New Hampshire, Durham, N. H. 1935
Jackson, John W., Associate Professor of Mechanical Engineering, University of Maryland, College Park, Md. 1943
Jackson, Kenneth B., Professor of Applied Physics, University of Toronto, Toronto, Canada 1943
Jackson, Norman E., Instructor in Civil Engineering, Vanderbilt University, Nashville, Tenn. 1944
Jackson, Willis, Assistant Professor of Mathematics and Mechanical Engineering, A. & T. College, Greensboro, N. C. 1943
Jacobs, L. S., Captain of Yard's Office, Navy Number 128, c/o Fleet Post Office, San Francisco, Calif. 1944
Jacobs, Roy Kenneth, Assistant Professor of Civil Engineering, Duke University, Durham, N. C. **In military service** 1943
Jacobs, Sidney N., President, Electronic Radio-Television Institute, Inc., 2055 Harney St., Omaha, Nebr. 1944
Jacobus, D. S., Retired, 93 Harrison St., Montclair, N. J. 1893

JACOBY, HENRY S., Professor of Bridge Engineering, Emeritus, Cornell University, 3000 Tilden St., N.W., Washington, D. C. (*President, 1915–6; Vice President, 1913–4; Secretary, 1900–2; Member of Council, 1900–5; 1915–.*) 1894

JAGGER, JAMES E., Acting Assistant Secretary, American Society of Civil Engineers, 33 W. 39th St., New York City 1942

JAKKULA, A. A., Acting Vice-Director, Engineering Experiment Station, A. & M. College of Texas, College Station, Texas 1938

JAKOB, MAX, Research Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. 1941

JAKOSKY, JOHN J., Assistant to President, University of Southern California, Los Angeles, Calif. 1942

JAMES, RICHARD V., Professor of Mechanics, University of Oklahoma, Norman, Okla. 1937

JAMEYSON, BRUCE, Professor of Civil Engineering, University of California, Berkeley, Calif. 1943

JAMIESON, ROBERT E., William Scott Professor and Chairman, Dept. of Civil Engineering, McGill University, Montreal, Canada. **In military service** 1929

JANES, CLINTON W., Liaison Officer to Chief Signal Officer, Mass. Inst. Tech., Cambridge, Mass. **In military service** 1938

JANSSEN, ALLEN S., Assistant Professor and Testing Engineer, in Civil Engineering, University of Idaho, Moscow, Idaho. **In military service** 1931

JAPPE, KURT W., Manager, Detonator Operations, Hercules Powder Co., Wilmington, Del. 1931

JENKINS, HOWARD M., Professor and Chairman, Dept. of Electrical Engineering, Swarthmore College, Swarthmore, Pa. 1931

JENKINS, JOBE, Instructor in Electrical Engineering, Case School of Applied Science, Cleveland, Ohio. **In military service** 1943

JENNINGS, BURGESS H., Professor and Chairman, Dept. of Mechanical Engineering, Northwestern Technological Institute, Evanston, Ill. .. 1933

JENNINGS, ROY T., Assistant Professor of Civil Engineering, North Dakota Agricultural College, Fargo, N. D. 1939

JENSEN, ALFRED, Assistant Professor of General Engineering, University of Washington, Seattle, Wash. 1932

JESSUP, WALTER E., Acting Assistant Secretary, American Society of Civil Engineers, 33 W. 39th Street, New York City. **In military service.** 1937

JETT, CARTER C., Professor of Machine Design, University of Kentucky, Lexington, Ky. 1925

JETT, DANIEL B., Dean of Engineering, New Mexico A. & M. College, State College, N. M. 1944

JEWELL, WILLIAM R., Instructor in Drawing and Machine Design, University of Colorado, Boulder, Colo. 1941

JEWETT, F. B., Vice President, American T. & T. Co., Chairman, Board of Directors, Bell Telephone Laboratories, Inc., 195 Broadway, New York, N. Y. 1914

JOERGER, C. ALBERT, Professor of Mechanical Engineering, University of Cincinnati, Cincinnati, Ohio 1929

JOFFE, JOSEPH, Professor of Chemical Engineering, Newark College of Engineering, Newark, N. J. 1937

JOHNS, WILLIAM B., JR., Professor and Head, Dept. Drawing and Mechanics, Georgia School of Technology, Atlanta, Ga. 1935

JOHNSON, A. MORGAN, Instructor in Theoretical and Applied Mechanics Iowa State College, Ames, Iowa. **In military service** 1943

JOHNSON, ALBERT P., Assistant Director of Personnel, Purdue University, Lafayette, Ind. **In military service** 1941
JOHNSON, A. R., Professor of Structural Design, Rutgers University, New Brunswick, N. J. *1909
JOHNSON, BERTRAM C., Instructor in Engineering Drawing, Iowa State College, Ames, Iowa. **In military service** 1914
JOHNSON, C. DAVID, Assistant Professor of Physics, Northeastern University, Boston, Mass. 1940
JOHNSON, CARLES F., Research Physicist, The Bristol Co., Waterbury, Mass. 1944
JOHNSON, CARL G., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1943
JOHNSON, EMORY E., Assistant Professor of Civil Engineering, South Dakota State College, Brookings, S. D. 1943
JOHNSON, ELMER W., Professor of Electrical Engineering, University of Minnesota, Minneapolis, Minn. 1926
JOHNSON, F. ELLIS, Dean, College of Engineering, University of Wisconsin, Madison, Wis. (*Member of Council, 1932–35.*) 1916
JOHNSON, GEORGE C. K., Associate Professor of Industrial Engineering, University of Alabama, University, Ala. 1943
JOHNSON, J. HUGO, Professor and Head, Department of Electrical Engineering, University of Idaho, Moscow, Ida. 1926
JOHNSON, LAWRENCE V., Professor of Aeronautics, Georgia School of Technology, Atlanta, Ga. 1943
JOHNSON, LEE H., Dean, Professor of Civil Engineering, University of Mississippi, University, Miss. 1937
JOHNSON, LEWIS O., Assistant Professor of Engineering Drawing, New York University, New York City 1939
JOHNSON, MAURICE F., Professor of Engineering, Hillyer Junior College, Hartford, Conn. 1936
JOHNSON, RALPH R., Industrial Coördinator, University of Detroit, Detroit, Mich. 1941
JOHNSON, ROYCE E., Chief Electrical Engineer, Barber-Colman Co., Rockford, Ill. 1943
JOHNSON, RUSSELL H., Assistant Professor of Mechanical Engineering, General Motors Institute of Technology, Flint, Mich. 1935
JOHNSON, STANLEY F., Instructor in History, Michigan College of M. & T., Houghton, Mich. 1944
JOHNSON, WALTER A., Assistant Professor of Machine Design, Cornell University, Ithaca, N. Y. 1941
JOHNSON, WALTER C., Associate Professor of Electrical Engineering, Princeton University, Princeton, N. J. 1943
JOHNSON, WILLIAM C., JR., Administrative Assistant, Goodyear Aircraft Corp., Akron, Ohio 1935
JOHNSTONE, B. KENNETH, Professor and Head, Dept. of Architecture, The Pennsylvania State College, State College, Pa. 1938
JOICE, CHARLES B., Director of Training, Naval Torpedo Station, Keyport, Wash. 1943
JONASSEN, FINN, Instructor in Mechanical Engineering, University of California, Berkeley, Calif. 1939
JONES, BRADLEY, Professor of Aeronautical Engineering, University of Cincinnati, Cincinnati, Ohio 1943
JONES, CHARLES B., Assistant Professor of Shop Practice, Pratt Institute, Brooklyn, N. Y. 1928

JONES, DOUGLAS K., Assistant Professor of Civil Engineering, University of Utah, Salt Lake City, Utah 1942
JONES, EDWARD N., President, Texas College of Arts and Industries, Kingsville, Texas 1942
JONES, EDWIN C., Associate Professor of Electrical Engineering, West Virginia University, Morgantown, W. Va. 1942
JONES, ELTON W., Instructor in Alternating Currents, Harvard University, Cambridge, Mass. 1944
JONES, FRED R., Professor and Head, Dept. of Agricultural Engineering, A. & M. College of Texas, College Station, Texas 1944
JONES, HERBERT L., Associate Professor of Electrical Engineering, University of New Mexico, Albuquerque, N. M. 1943
JONES, JAMES B., Professor and Head, Dept. of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1927
JONES, J. O., Dean, Professor of Hydraulics, University of Kansas, Lawrence, Kansas 1943
JONES, LAWRENCE D., Professor of Engineering Drawing, Ohio State University, Columbus, Ohio 1939
JONES, LYNN W., Radio and Electrical Engineer, Kaiser Co., Inc., Iron and Steel Div., Fontana, Calif. 1934
JONES, MERTON W., Assistant Professor of Science, Arizona State Teachers College, Flagstaff, Ariz. 1942
JONES, RALPH W., Assistant Professor of Mechanics, University of Delaware, Newark, Del. 1943
JONES, RICHARD W., Assistant Professor of Electrical Engineering, Northwestern University, Evanston, Ill. 1941
JONES, STEPHENS S., Research Associate in Plastics Lab., University of Kansas, Lawrence, Kans. 1943
JONES, WEBSTER N., Director, College of Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1933
JONES, WILLIAM H., Associate Professor of Heat Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1935
JONES, W. PAUL, Professor of English and Speech, Iowa State College, Ames, Iowa 1943
JONNARD, AIMISON, Instructor in Chemical Engineering, Kansas State College, Manhattan, Kans. 1944
JORDAN, HARVEY H., Professor and Head, General Engineering Drawing, and Associate Dean, College of Engineering, University of Illinois, Urbana, Ill. (*Vice President, 1931–32; Member of Council, 1924–7.*) 1915
JORDAN, HERBERT E., Associate Professor of Mathematics, University of Kansas, Lawrence, Kans. 1924
JORDAN, H. G., Professor and Head, Dept. of Electrical Engineering, Colorado State College, Fort Collins, Colo. 1926
JORDAN, WILLIAM, Assistant Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. 1940
JORGENSEN, ALBERT, Assistant Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. 1926
JORGENSON, L. M., Associate Professor of Electrical Engineering, Kansas State College, Manhattan, Kans. 1926
JOSEPH, BROTHER A., Instructor in Civil Engineering, Manhattan College, New York City 1943
JOSEPH, THOMAS L., Professor and Head, Dept. of Metallurgy, University of Minnesota, Minneapolis, Minn. 1944

JUDD, HORACE, Professor Emeritus of Mechanical Engineering, The Ohio State University, Columbus, O. 1907

JUDSON, WILLIAM J., Instructor in Engineering Drawing, University of Detroit, Detroit, Mich. **In military service** 1940

JUDY, CLINTON K., Professor of English, California Institute of Technology, Pasadena, Calif. 1943

JURDAK, MANSUR, Professor of Mathematics, Director of Engineering Classes, American University of Beirut, Beirut, Syria. 1929

JUSTICE, HOWARD K., Professor of Mathematics, University of Cincinnati, Cincinnati, Ohio 1944

JUSTIN, EDWARD M., Assistant Professor of Mathematics, University of California at Los Angeles, Calif. 1928

KALELKAR, BAL D., Instructor in Mechanics, Cornell University, Ithaca, N. Y. 1944

KALINSKE, ANTON A., Associate Professor of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa 1939

KAMPMEIER, ROLAND A., Chief, Division of Power Economics, T. V. A., Power Bldg., Chattanooga, Tenn. 1939

KAPP, CECIL A., Director, Coöperative Education, Drexel Institute of Technology, Philadelphia, Pa. 1929

KARR, J. HAROLD, Assistant Chief Engineer, Robbins & Myers, Inc., Springfield, Ohio 1939

KATZ, DONALD L., Professor of Chemical Engineering, University of Michigan, Ann Arbor, Mich. 1944

KAUPPINEN, TENHO S., Instructor in Mechanical Engineering, University of New Hampshire, Durham, N. H. 1940

KAVANAUGH, DENNIS, JR., Professor of Mechanical Engineering, Post Graduate School, U. S. Naval Academy, Annapolis, Md. 1925

KAYAN, CARL F., Associate Professor of Mechanical Engineering, Columbia University, New York City 1935

KAYE, JOSEPH, Assistant Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943

KEATON, L. D., Associate Professor of Industrial Education, East Texas State Teachers College, Commerce, Texas 1934

KEATOR, FREDERIC W., Assistant Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1929

KEBERNICK, OTTO C., Electronics Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1942

KEEFE, GEORGE C., Associate Professor of Chemical Engineering, Newark College of Engineering, Newark, N. J. 1943

KEELER, HUGH E., Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1926

KEENAN, JOSEPH H., Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1938

KEENE, ARCHIE T., President, Indiana Technical College, Ft. Wayne, Ind. 1943

KEENER, CHARLES A., Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1944

KEEVER, LEROY M., Associate Professor of Electrical Engineering, North Carolina State College, Raleigh, N. C. 1942

KEEVIL, CHARLES S., Professor of Chemical Engineering, Bucknell University, Lewisburg, Pa. 1936

KEGERREIS, ROY, Physician, 145 W. North Ave., Elmhurst, Ill. (Life Member.) 1913

KEHL, GEORGE L., Assistant Professor of Metallurgy, Columbia University, New York City 1941

KEITH, GERALD M., Associate Professor of Civil Engineering, University of Florida, Gainesville, Fla. 1941
KEITH, HENRY H. W., Professor of Naval Architecture, Massachusetts Institute of Technology, Cambridge, Mass. 1940
KEITH, JESSE I., Professor and Head, Dept. of Food Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1940
KEITH, WARREN G., Assistant Professor of Civil Engineering, University of Alabama, University, Ala. 1943
KEITH, W. E., Personnel Staff Assistant, New England Tel. & Tel. Co., 50 Oliver St., Boston, Mass. 1939
KELLER, ARTHUR R., Dean, College of Applied Science, University of Hawaii, 2456 Oahn Avenue, Honolulu, T. H. 1910
KELLER, EDWARD L., Director of Engineering Extension, The Pennsylvania State College, State College, Pa. 1943
KELLOGG, JOSEPH M., Professor and Head, Department of Architecture, University of Kansas, Lawrence, Kansas 1935
KELLS, LYMAN M., Associate Professor of Mathematics, U. S. Naval Academy, Annapolis, Md. 1942
KELLY, JOE W., Associate Professor of Civil Engineering, University of California, Berkeley, Calif. 1940
KELSO, LESLIE E. A., Assistant Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1940
KEMLER, EMORY, Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1929
KEMMER, LLOYD H., Instructor in Civil Engineering, Purdue University, Lafayette, Ind. **In military service** . 1938
KENERSON, W. H., Professor of Mechanical Engineering, Emeritus, Brown University, Providence, R. I. (*Member of Council, 1924–7.*) 1903
KENNEDY, R. E., Secretary, American Foundrymen's Association, 222 West Adams St., Chicago, Ill. 1941
KENNY, FREDERICK J., Professor and Head, Dept. of Chemistry, St. Francis College, New York City 1934
KENRICK, GLEASON W., Professor of Physics, University of Porto Rico, Rio Pedras, P. R. 1927
KENT, BENJAMIN C., Professor and Head, Dept. of Engineering Drafting, University of Maine, Orono, Me. 1941
KENT, CLARENCE H., Associate Professor of Mechanical Engineering College of the City of New York, New York City 1939
KENYON, VAN L., Curtiss-Wright Corp., Box 244, Beaver, Pa. 1943
KEPLER, FRANK R., Associate Professor of Industrial Arts Education, Wayne University, Detroit, Mich. 1943
KEPNER, HAROLD R., Professor of Civil Engineering, Utah State Agricultural College, Logan, Utah 1930
KERCHNER, RUSSELL M., Professor of Electrical Engineering, Kansas State College, Manhattan, Kans. 1923
KEREKES, FRANK, Professor of Civil Engineering, Iowa State College, Ames, Iowa 1927
KESLER, MACK S., Instructor in Civil Engineering, University of Utah, Salt Lake City, Utah 1942
KESNER, HENRY J., Professor of Civil Engineering, University of Nebraska, Lincoln, Nebr. 1921
KETCHUM, MILO S., JR., Associate, Floyd G. Browne & Associates, Marion, Ohio 1938
KEY, JOHN C., Assistant Professor of Civil Engineering, The Citadel, Charleston, S. C. 1943

KEYES, DONALD B., Professor and Head, Division of Chemical Engineering, University of Illinois, Urbana, Ill. 1928

KIEFER, PAUL J., Senior Professor of Mechanical and Marine Engineering, Post Graduate School, U. S. Naval Academy, Annapolis, Md. 1917

KIELY, EDMOND R., Professor of Engineering Drawing and Surveying, Iona College, New Rochelle, N. Y. 1942

KIERNAN, CHARLES J., Assistant Professor of Civil Engineering, Newark College of Engineering, Newark, N. J. 1931

KILCAWLEY, EDWARD J., Professor of Soil Mechanics and Sanitary Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1940

KILLIAN, J. R., Executive Vice President, Massachusetts Institute of Technology, Cambridge, Mass. 1939

KIMBALL, ALLEN H., Professor and Head, Department of Architectural Engineering, Iowa State College, Ames, Iowa 1931

KIMBALL, D. S., Emeritus, Professor of Mechanical Engineering, Cornell University, Ithaca, N. Y. *(President, 1928–29; Vice President, 1922–23; Member, Board of Investigation and Coordination, 1921–; Member of Council, 1928–.)* **Sixth Recipient Lamme Medal (1933).** 1915

KIMBALL, ROBERT M., Assistant to President, Massachusetts Institute of Technology, Cambridge, Mass. 1944

KIMBALL, SPOFFARD H., Associate Professor and Head, Dept. of Mathematics and Astronomy, University of Maine, Orono, Me. 1943

KIMBALL, WM. P., Professor of Civil Engineering, Thayer School of Engineering, Hanover, N. H. 1933

KIMBARK, EDWARD W., Associate Professor of Electrical Engineering, Northwestern University, Evanston, Ill. 1936

KIMBERLY, EMERSON E., Professor of Electrical Engineering, The Ohio State University, Columbus, Ohio 1943

KINDIG, C. H., Associate Professor of Civil Engineering, Bucknell University, Lewisburg, Pa. 1939

KINDLE, JOSEPH H., Professor of Mathematics, University of Cincinnati, Cincinnati, Ohio 1914

KING, DAN M., Librarian-in-Charge, Cooper Union, New York City 1944

KING, EVERITT E., Professor of Railway Civil Engineering, University of Illinois, Urbana, Ill. 1908

KING, HAROLD J., Instructor in Metallurgy, University of Rochester, Rochester, N. Y. 1943

KING, JOHN A., Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y. 1935

KING, MORLAND, Professor and Head, Dept. of Electrical Engineering, Lafayette College, Easton, Pa. *(Member of Council, 1932–35.)* ... 1920

KING, RICHARD, Instructor in Civil Engineering, University of Connecticut, Storrs, Conn. In military service .. 1940

KING, ROBERT M., Professor of Ceramic Engineering, The Ohio State University, Columbus, Ohio 1937

KING, ROY S., Head, Department of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. *(Vice President, 1924–5; Member of Council, 1920–5.)* 1904

KINGMAN, EDWARD D., Head, Department of Applied Mechanics, Wentworth Institute, Boston, Mass. 1923

KINGSLEY, CHARLES, Assistant Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1940

KINNEY, EDWARD E., Supt. of Buildings and Utilities, Michigan State College, East Lansing, Mich. 1925

· KINNEY, GILBERT F., Head Instructor in Chemistry, Pratt Institute, Brooklyn, N.Y. **In military service** 1935
KINNEY, JOSEPH S., Assistant Professor of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1936
KINSLOE, CHARLES L., Emeritus Professor, The Pennsylvania State College, State College, Pa. (*Member of Council, 1939–42.*) 1926
KINTNER, ROBERT C., Professor of Chemical Engineering, Illinois Institute of Technology, Chicago, Ill. 1934
KIPP, HAROLD L., Associate Professor of Mechanical Engineering, Texas Technological College, Lubbock, Texas. **In military service** 1938
KIRBY, LONGLEY R., 809 N. 5th St., Nashville 7, Tenn. 1943
KIRKENDELL, ERNEST O., Assistant Professor of Chemical Engineering, Wayne University, Detroit, Mich. 1943
KIRKPATRICK, ERNEST L., Associate in Physics, George Washington University, Washington, D. C. 1943
KIRKPATRICK, SIDNEY D., Editor, Chemical and Metallurgical Engineering, 330 West 42nd St., New York 18, N. Y. 1942
KISSAM, PHILIP, Associate Professor of Civil Engineering, Princeton University, Princeton, N. J. 1934
KISTLER, PAUL N., Associate Professor of Mechanical Engineering, Brown University, Providence, R. I. 1931
KITTREDGE, RAYMOND B., Professor of Transportation Engineering, State University of Iowa, Iowa City, Ia. 1921
KLEIN, GEORGE W., Instructor in Mechanical Engineering, Ohio Northern University, Ada, Ohio 1943
KLEINSCHMIDT, R. B., Assistant Professor of General Engineering, Rutgers University, New Brunswick, N. J. 1939
KLEMIN, ALEXANDER, Daniel Guggenheim Research Professor of Aeronautics, New York University, New York City 1926
KLOEFFLER, ROYCE G., Professor and Head, Department of Electrical Engineering, Kansas State College, Manhattan, Kans. 1919
KNAEBEL, CARL H., Associate Professor of Mathematics, Michigan College of M. & T., Houghton, Mich. 1940
KNAPP, WILLARD A., Associate Dean of Engineering, Purdue University, Lafayette, Ind. 1920
KNIGHT, ABNER R., Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1929
KNIGHT, ARTHUR J., Professor of Civil Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1926
KNIGHT, ODON S., Assistant Professor of Chemical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1941
KNIGHT, RAYMOND M., Instructor in Mathematics, Wentworth Institute, Boston, Mass. 1942
KNIGHT, W. A., Professor of Mechanical Practice, Emeritus, The Ohio State University, Columbus, O. 1907
KNIPMEYER, CLARENCE C., Professor of Electrical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1929
KNOLL, HORTON B., Assistant Professor of English, Purdue University, Lafayette, Ind. 1940
KNOWLES, MAHLON G., Instructor in Applied Science, Wentworth Institute, Boston, Mass. 1922
KNUDSON, CLARENCE M., Dean, School of Engineering, University of Denver, Denver, Colo. 1941
KOCH, RUTH L., Cashier, University of Louisville, Louisville, Ky. 1927

KOEHLER, W. A., Professor of Chemical and Ceramic Engineering, West Virginia University, Morgantown, W. Va. 1936
KOENIG, LLOYD R., Assistant Professor of Mechanical Engineering, Washington University, St. Louis, Mo. 1931
KOENIG, LOUIS A., Assistant Professor of Chemistry, A. & M. College of Texas, College Station, Texas 1937
KOENITZER, LESTER H., Associate Professor of Applied Mechanics, Kansas State College, Manhattan, Kans. 1929
KOEPKE, CHARLES A., Administrative Assistant, University of Minnesota, Minneapolis, Minn. 1929
KOFFOLT, JOSEPH H., Professor of Chemical Engineering, The Ohio State University, Columbus, Ohio 1933
KOHLER, ARTHUR S., Assistant Professor of Chemistry, Newark College of Engineering, Newark, N. J. 1932
KOHLER, HENRY L., Assistant Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. **In military service** 1940
KOLB, ROBERT P., Professor of Heat-Power Engineering, Worcester Polytechnic Institute, Worcester, Mass. **In military service** 1925
KOLB, WILLIAM K., Director, Production Engineering, Remington-Rand Inc., Springfield, Ill. 1937
KOMAREWSKY, VASILI T., Professor of Chemistry and Chemical Engineering, Illinois Institute of Technology, Chicago, Ill. 1941
KOMMERS, JESSE B., Professor of Mechanics, University of Wisconsin, Madison, Wis. 1923
KONOVE, CARL, Assistant Professor of Mathematics, Newark College of Engineering, Newark, N. J. 1941
KOOPMAN, RICHARD J. W., Head, Electro-Mechanics Section, Curtiss-Wright, Buffalo 5, N. Y. 1939
KOTH, ARTHUR W., Assistant Professor of Chemical Engineering, University of North Dakota, Grand Forks, N. D. 1935
KOUWENHOVEN, WILLIAM B., Dean, School of Engineering, Professor of Electrical Engineering, The Johns Hopkins University, Baltimore, Md. 1938
KOVARIK, ALOIS F., Professor of Physics, Yale University, New Haven, Conn. 1919
KOWALKE, OTTO L., Professor of Chemical Engineering, University of Wisconsin, Madison, Wis. 1918
KOZACKA, JOSEPH S., Associate Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. 1938
KRAEHENBUEHL, JOHN O., Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1940
KRATHWOHL, WM. C., Professor of Mathematics, Director, Dept. of Educational Tests and Measurements, Illinois Institute of Technology, Chicago, Ill. 1927
KRAYBILL, EDWARD K., Instructor in Electrical Engineering, Duke University, Durham, N. C. 1940
KREFELD, WILLIAM J., Associate Professor of Civil Engineering, Columbia University, New York City 1929
KREYDICH, WALTER, 12527 So. Marshfield Ave., Chicago, Ill. 1941
KROEGER, HENRY R., Assistant Professor of Mechanical Engineering, University of Oklahoma, Norman, Okla. 1942
KRUMLAUF, HARRY E., Associate Professor of Mining Engineering, University of Arizona, Tucson, Ariz. 1944
KRUSZKA, EDWARD J., Dean, Technical Institute of Alliance Junior College, Cambridge Springs, Pa. 1943

KRYNINE, D. P., Research Associate in Soil Mechanics, Yale University, New Haven, Conn. 1934
KUETHE, ARNOLD M., Professor of Aeronautical Engineering, Acting Chairman, University of Michigan, Ann Arbor, Mich. 1942
KUHLEN, FREDERICK, Associate Professor and Chairman, Dept. of Mechanical Engineering, College of the City of New York, New York City 1935
KUHLMAN, JOHN H., Associate Professor of Electrical Design, University of Minnesota, Minneapolis, Minn. 1925
KULP, MARK R., Associate Professor of Agricultural Engineering, Irrigationist, Agricultural Experiment Station, University of Idaho, Moscow, Ida. 1934
KUMMERLE, HARRISON M., First Assistant in Mechanic Arts, Straubenmuller Textile High School, New York City 1944
KUNKLE, GEORGE M., Associate Professor of Mechanical Engineering, Bucknell University, Lewisburg, Pa. 1925
KUNZ, RAYMOND J. F., Director of Technical Development, Hoffman La Roche, Inc., Nutley, N. J. 1940
KURTZ, E. B., Professor and Head, Department of Electrical Engineering, University of Iowa, Iowa City, Iowa 1921
KURTZ, GODFREY H., President, Industrial Engineering College, 4000 West West Washington Blvd., Chicago, Ill. 1943
KURTZ, JOHN W., Head, Engineering Department, Municipal University of Omaha, Omaha, Nebr. 1934
KURZWEIL, ARTHUR C., Assistant Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1940
KUT, WALTER S., Instructor in Mechanical Engineering, Cooper Union, New York City. In military service 1938
KYLE, P. E., Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1939
LABBERTON, JOHN M., Professor of Marine Engineering, New York University, New York City 1937
LADNER, A. COLLINS, Assistant Professor of Mathematics and Engineering Science, Denison University, Granville, Ohio 1934
LAESTADIUS, JOHN E., Instructor in Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1942
LAGAARD, M. B., Assistant Professor of Civil Engineering, Northwestern University, Evanston, Ill. 1942
LAITALA, EVERETT, Assistant Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1941
LAKE, ROBERT E., Assistant Professor of Electrical Engineering, Pratt Institute, Brooklyn, N. Y. 1944
LAKE, WILFRED S., Dean, College of Liberal Arts, Northeastern University, Boston, Mass. 1939
LAMB, JOHN F., Assistant Professor of Electrical Engineering, University of Missouri, Columbia, Mo. 1937
LAMBE, EMERSON P., Head, Dept. of Physics, Pratt Institute, Brooklyn, N. Y. 1926
LAMBERT, B. J., Professor and Head, Dept. of Civil Engineering, State University of Iowa, Iowa City, Ia. 1907
LAMBERTINE, JOSEPH A., Assistant Professor of Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1928
LAMBIE, JOS. S., Director, Civilian Training Consultant O.C.O., U. S. Army, Washington, D C. 1914

LAMPE, JOHN H., Dean of Engineering, North Carolina State College, Raleigh, N. C. 1938
LANCASTER, FORREST W., Associate Professor of Physics, North Carolina State College, Raleigh, N. C. 1937
LANCOUR, HAROLD, Librarian and Assistant Professor of Bibliography, The Cooper Union, New York City 1942
LANDON, RANSOM D., Professor of Civil Engineering, Southern Methodist University, Dallas, Texas 1937
LANE, DONALD F., Director of Training, Bethlehem Steel Co., Sparrows Point, Md. 1930
LANE, EMORY W., Professor of Hydraulic Engineering, State University of Iowa, Iowa City, Iowa 1935
LANE, RUTH McG., Librarian, Vail Library, Massachusetts Institute of Technology, Cambridge, Mass. 1941
LANGDON, HOWARD H., Head, Research and Development, Consolidated Mach. Tool Corp., Rochester, N. Y. 1936
LANGE, ERNEST O., Associate Professor of Electrical Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937
LANGENHEIM, RALPH L., Dean of Engineering, University of Tulsa, Tulsa, Okla. 1938
LANGILLE, H. B., Associate Professor of Mechanical Engineering, Emeritus, University of California, Berkeley, Calif. 1915
LANGSDORF, ALEXANDER S., Dean, Schools of Engineering and Architecture, Washington University, St. Louis, Mo. (*Member of Council, 1913–16.*) 1903
LANGSNER, ADOLPH, Professor of Management, Northwestern University, Chicago 45, Ill. 1938
LANING, WILLARD A., Engineer, Westinghouse E. & M. Co., Electronics Eng. Div., Bloomfield, N. J. 1930
LANSFORD, WALLACE M., Associate Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1935
LANSIL, CLIFFORD E., Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1925
LA PIERRE, WALTER A., Instructor in Electrical Engineering, Columbia University, New York City 1943
LARGE, GEORGE E., Professor of Civil Engineering, The Ohio State University, Columbus, Ohio 1940
LARIAN, MAURICE G., Associate Professor of Chemical Engineering, Michigan State College, East Lansing, Mich. 1937
LARK-HOROVITZ, K., Professor and Head, Dept. of Physics, Purdue University, Lafayette, Ind. 1942
LARKIN, F. V., Director of Mechanical Engineering, Lehigh University, Bethlehem, Pa. (*Member of Council, 1930–33; Vice President, 1933–34.*) 1912
LARKIN, JOHN D., Professor and Chairman, Dept. of Political Science, Illinois Institute of Technology, Chicago, Ill. 1939
LAROZA, ENRIQUE, Director de la Escuela de Ingenieros, Lima, Peru, S. A. 1943
LARSEN, MERWIN J., Engineer, Research Dept., Stromberg-Carlson, Rochester, N. Y. 1938
LARSON, C. WILLIAM, Instructor in Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. **In military service** 1929
LARSON, EDWARD, Executive Secretary, National Society of Professional Engineers, National Press Bldg., Washington 4, D. C. 1944
LARSON, G. L., Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis. 1911

Larson, Ludvig C., Assistant Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1937
Larson, Reinhold F., Assistant Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1939
LaRue, Harry A., Associate Professor of Civil Engineering, University of Missouri, Columbia, Mo. 1939
Lascoe, Orville D., Instructor in General Engineering, Purdue University, Lafayette, Ind. 1944
Lassalle, Leo J., Professor of Engineering Mechanics, Dean, College of Engineering, Louisiana State University, University, La. 1935
Latimer, Claiborne G., Professor of Mathematics, University of Kentucky, Lexington, Ky. 1943
Latimer, Clara A., Assistant Professor of Civil Engineering, University of Utah, Salt Lake City, Utah 1940
Lauer, Bryon E., Professor of Chemical Engineering, North Carolina State College, Raleigh, N. C. In military service 1937
Laurence, Jacques, Assistant Professor of Electrical Engineering, Ecole Polytechnique, Montreal, Canada 1942
Laurson, Philip G., Associate Professor of Engineering Mechanics, Yale University, New Haven, Conn. 1920
La Valle, Peter F., Engineer Examiner, U. S. Civil Service Commission, Washington, D. C. 1944
Lavine, Irvin, Sec. Treas., Industrial Research Service, Masonic Bldg., Dover, N. H. 1935
Lawall, Charles E., President, West Virginia University, Morgantown, W. Va. (*Member of Council, 1942–45.*) 1931
Lawler, Leo T., Associate Professor of English, Carnegie Institute of Technology, Pittsburgh, Pa. 1937
Lawrence, E. George, President, Lawrence Institute of Technology, Detroit, Mich. 1943
Layton, William I., Instructor in Engineering and Mathematics, Amarillo Junior College, Amarillo, Texas 1941
Leahy, John F., Director, Texas Cotton Research Institute, A. & M. College of Texas, College Station, Texas 1943
Lear, John E., Professor of Electrical Engineering, North Carolina State College, Raleigh, N. C. 1938
Lease, L. J., Industrial Coordinator, Illinois Institute of Technology, Chicago, Ill. 1939
Leblanc, Fernand, Assistant Professor of Electrical Engineering, Ecole Polytechnique, Montreal, Canada 1942
Lee, Claudius, Professor of Electrical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1935
Lee, Everett S., Engineer, General Engineering Laboratory, General Electric Co., Schenectady, N. Y. 1943
Lee, George H., Assistant Professor of Mechanics, Cornell University, Ithaca, N. Y. 1941
Lee, Roland L., Cotton Technologist and Educational Director, Callaway Institute, Inc., La Grange, Ga. 1940
Lees, James W., Dean, Lincoln Technical Institute, Boston, Mass. 1942
Leet, Horace W., Professor of Mechanical Drawing and Machine Design, University of Rochester, Rochester, N. Y. 1944
Lefavour, Roland W., Assistant Professor of Civil Engineering, Tufts College, Medford, Mass. 1921
Legault, Adrian R., Assistant Professor of Civil Engineering, Colorado State College, Ft. Collins, Colo. 1940

LEGGET, ROBERT F., Associate Professor of Civil Engineering, University of Toronto, Toronto, Ont. 1940
LEHMAN, L. GRAHAM, Electrical Engineer, Glenn L. Martin Aircraft Plants, Baltimore 3, Md. 1939
LEHMANN, CHARLES H., Instructor in Mathematics, Cooper Union, New York City 1941
LEHMANN, EMIL W., Professor and Head, Department of Agricultural Engineering, University of Illinois, Urbana, Ill. 1935
LEHOCZKY, PAUL N., Professor and Chairman, Dept. of Industrial Engineering, Ohio State University, Columbus, Ohio 1930
LEIGHTON, ARTHUR W., Professor of Engineering Drawing, Freshman Advisor, Tufts College, Medford, Mass. 1922
LEIGHTON, TOMAS, Facultad de Ciencias Fisicas y Matematicas, Universidad de Chile, Santiago, Chile, S. A. 1943
LEISTER, JOHN S., Associate Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. **In military service** 1934
LELAND, O. M., Dean Emeritus, University of Minnesota, Minneapolis, Minn. (*President, 1926–7; Member of Council, 1921–4; 1926–.*) 1908
LENDALL, HARRY N., Professor and Head, Dept. of Civil Engineering, Rutgers University, New Brunswick, N. J. 1912
LENDRUM, JAMES T., Assistant Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. 1943
LENG, RICHARD B., Manager, Central Planning, RCA Mfg. Co., Lancaster, Pa. 1937
LENHART, JACK, Assistant Professor of Drawing, University of Texas, Austin, Texas 1944
LENZ, ARNO T., Associate Professor of Hydraulic Engineering, University of Wisconsin, Madison, Wis. 1938
LEO, BROTHER AMANDUS, Dean of Engineering, Manhattan College, New York City 1928
LEONARD, CARROLL M., Associate Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1930
LEONARD, HEMAN BURR, Professor of Mathematics, University of Arizona, Tucson, Ariz. 1919
LEONARD, SAMUEL J., Professor of Civil Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1928
LEPAGE, CLIFFORD B., Assistant Secretary, The American Society of Mechanical Engineers, 29 West 39th St., New York City 1908
LERNER, SAMUEL, Assistant Professor of Civil Engineering, Brown University, Providence, R. I. 1941
LESLIE, MYRON W., Head, Employment Section, Naval Ordnance Lab., 4205 Kaywood Drive, Mt. Ranier, Md. 1944
LESSER, ARTHUR, Assistant Professor of Industrial Management, Stevens Institute of Technology, Hoboken, N. J. 1943
LESTER, BERNARD, Assistant Manager, Industrial Dept., Westinghouse E. & M. Co., 40 Wall St., New York City 1936
LESTER, OLIVER C., Professor of Physics, Vice President and Dean of Graduate School, Emeritus, University of Colorado, Boulder Colo. .. 1912
LETELLIER, L. S., Head, Dept. of Engineering, Professor of Civil Engineering, The Citadel, Charleston, S. C. 1912
LEUTWILER, O. A., Professor and Head, Department of Mechanical Engineering, University of Illinois, Urbana, Ill. (*Member of Council, 1918–21.*) 1906
LEUTWILER, RICHARD W., Assistant Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1941

LEVENS, A. S., Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1932

LEVINE, JACK, Associate Professor of Mathematics, North Carolina State College, Raleigh, N. C. **In military service** 1940

LEVY, GEORGE F., Instructor in Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1944

LEWELLEN, MARCY T., Professor and Head, Dept. of Mechanical Engineering, State Teachers College, Flagstaff, Ark. 1938

LEWIS, ALEXANDER D., Assistant Professor and Visiting Lecturer, Dept. of Mechanical Engineering, Yale University, New Haven, Conn. 1943

LEWIS, FRED J., Dean, School of Engineering, Vanderbilt University, Nashville, Tenn. 1926

LEWIS, J. F., Assistant Electrical Engineer, U. S. Navy Yard, 505 Brinton St., Germantown, Philadelphia, Pa. (Life Member.) 1913

LEWIS, RALPH E., Assistant Professor of Mechanical Engineering, Duke University, Durham, N. C. 1931

LEWIS, ROBERT L., Assistant Professor of Civil Engineering, Colorado State College, Ft. Collins, Colo. 1939

LEWIS, ROBERT S., Professor of Mining, University of Utah, Salt Lake City, Utah 1922

LEWIS, SELKIRK C., Professor and Head, Dept. of Chemical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1943

LEWIS, WARREN K., Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1932

LEWIS, WILLIAM A., Research Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1939

LEWISOHN, SAM A., Vice President and Treasurer, Miami Copper Company, 61 Broadway, New York City 1929

LICHT, WILLIAM, Assistant Professor of Chemical Engineering, University of Cincinnati, Cincinnati, Ohio 1943

LICHTY, LESTER C., Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1930

LICKEY, HARRY F., Associate Professor of Communication Engineering, Washington State College, Pullman, Wash. 1936

LIDDICOAT, RICHARD T., Assistant Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. 1940

LIGHTBURN, FRANK E., Associate Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa. **In military service** .. 1937

LILLY, SCOTT B., Professor of Civil Engineering and Chairman, Division of Engineering, Swarthmore College, Swarthmore, Pa. 1913

LIND, SAMUEL C., Dean, Institute of Technology, University of Minnesota, Minneapolis, Minn. 1935

LINDAHL, ERIC J., Assistant Professor of Mechanical Engineering, The Ohio State University, Columbus, Ohio 1941

LINDELL, W. FRANCIS, Assistant Professor of Mechanical Engineering, University of Delaware, Newark, Del. 1941

LINDEMAN, MARVEL F., Assistant Professor of Civil Engineering, Wayne University, Detroit, Mich. 1938

LINDEMANN, ABERT J., 8314 Carey Lane, Silver Springs, Md. **In military service** 1939

LINDENMEYER, RAY S., Assistant Professor of Industrial Engineering, Northwestern University, Evanston, Ill. 1943

LINDLEY, ROY W., Professor of Practical Mechanics, Purdue University, Lafayette, Ind. 1922

LINDSAY, FRANK B., Assistant Superintendent of Public Instruction, State Dept. of Education, P.O. Box 25, Sacramento, Calif. 1928
LINDSAY, JAMES D., Professor and Head, Dept. of Chemical Engineering, A. & M. College of Texas, College Station, Texas 1936
LINDSAY, LOUIS, Professor of Applied Mathematics, Syracuse University, Syracuse, N. Y. 1941
LINDVALL, FREDERICK C., Professor of Electrical and Mechanical Engineering, California Institute of Technology, Pasadena, Calif. 1941
LINGEMAN, CYRIL A., Instructor in English, University of Detroit, Detroit, Mich. 1941
LIPPITT, VERNON G., Assistant Professor of Electrical Engineering, Northwestern University, Evanston, Ill. 1943
LIRA ORREGO, PEDRO, Director, Facultad de Ciencias Fisicas y Matematicas, Universidad Catolica de Chile, Santiago, Chile, S. A. 1943
LISSNER, HERBERT R., Assistant Professor of Mechanics, Wayne University, Detroit, Mich. 1943
LISTON, JOSEPH, Associate Professor of Aeronautical Engineering, Purdue University, Lafayette, Ind. 1944
LITKENHOUS, EDWARD E., Professor and Head, Dept. of Chemical Engineering, Vanderbilt University, Nashville, Tenn. 1936
LITTLEFIELD, GARNETT, Instructor in General Engineering, Weber College, Ogden, Utah 1943
LITTLETON, EARLE F., Assistant Professor of Civil Engineering, Tufts College, Medford, Mass. 1938
LIUM, ELDER L., Associate Professor of Civil Engineering, University of North Dakota, Grand Forks, N. D. 1940
LIVINGOOD, MARVIN D., Instructor in Chemical Engineering, Missouri School of Mines, Rolla, Mo. 1941
LIVINGSTON, ARNOLD R., Instructor in Engineering Drawing, Iowa State College, Ames, Iowa 1944
LIWSCHITZ-GARIK, MICHAEL, Adjunct Professor of Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1942
LLOYD, HAROLD RHYS, Associate Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1926
LOCKE, ARTHUR A., Associate Professor and Head, Dept. Aeronautical Engineering, Wayne University, Detroit, Mich. 1944
LOCKE, CHARLES E., Professor Emeritus of Mining Engineering and Ore Dressing, Massachusetts Institute of Technology, Alumni Secretary, Cambridge, Mass. 1924
LOCKE, WILLIAM W., JR., Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1934
LOEW, EDGAR A., Dean, College of Engineering, Professor of Electrical Engineering, University of Washington, Seattle, Wash. (*Member of Council, 1944–47.*) 1936
LOEWNER, CHARLES, Assistant Professor of Mathematics, University of Louisville, Louisville, Ky. 1943
LOFGREN, KENNETH E., Assistant Professor of Machine Design, Cooper Union, New York City 1936
LOFLIN, ZEKE L., Professor of Chemical Engineering, Southwestern Louisiana Institute, Lafayette, La. 1944
LOHR, WM. S., Professor and Head, Dept. of Civil Engineering, Lafayette College, Easton, Pa. 1927
LOMMEL, GEORGE E., Professor of Topographical Engineering, Purdue University, Lafayette, Ind. 1926

LONDON, ALEXANDER L., Assistant Professor of Mechanical Engineering, Stanford University, Palo Alto, Calif. 1940

LONG, JAMES D., Research Director, Douglas Fir Plywood Assn., Tacoma, Wash. 1932

LONG, MAURICE B., Assistant to Vice President, Bell Telephone Laboratories, 463 West Street, New York, N. Y. 1930

LONGACRE, WILLIAM A., Associate Professor of Mathematics and Physics, Michigan College of M. & T., Houghton, Mich. 1943

LONGWELL, WILLIAM F. M., Assistant Professor of Civil Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1944

LOONEY, CHARLES T. G., Assistant Professor of Civil Engineering, State University of Iowa, Iowa City, Iowa 1937

LORAH, JAMES R., Associate Professor of Chemical Engineering, University of Missouri, Columbia, Mo. 1928

LOTT, ARWYNE O., Switchgear Test, Westinghouse E. & M. Co., 887 Peachtree St., N.E., Atlanta, Ga. 1941

LOVELL, ALFRED H., Professor and Acting Chairman, Dept. of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1920

LOVELL, CLIFTON L., Associate Professor of Chemical Engineering, Purdue University, Lafayette, Ind. 1936

LOVELL, WILLIAM E., Professor of Electrical Engineering, University of Saskatchewan, Saskatoon, Sask. 1937

LOVETT, I. H., Professor of Electrical Engineering, University of Missouri, Rolla, Mo. 1921

LOVING, ROBERT O., Assistant Professor of Technical Drawing, Illinois Institute of Technology, Chicago, Ill. 1942

LOWE, THOMAS M., Professor and Head, Dept. of Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1928

LOWEKE, GEORGE P., Instructor in Mechanics, Wayne University, Detroit, Mich. 1943

LUCARINI, GENO B., Assistant Professor of Mechanical Engineering, University of Vermont, Burlington, Vt. 1929

LUCAS, ERNEST L., Professor of Mechanical Engineering, Mississippi State College, State College, Miss. **In military service** 1939

LUCE, ALEXANDER W., Supervisor of Training, The Fellows Gear Shaper Co., Springfield, Vt. 1932

LUDDEN, DWIGHT J., Director, Vocational Dept., Community High School, Granite City, Ill. **In military service** 1933

LUDT, RANDALL W., Assistant Professor of Chemical Engineering, Michigan State College, East Lansing, Mich. 1939

LUDWICKSON, JAMES K., Assistant Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. 1938

LUDY, L. V., Professor of Experimental Engineering, Purdue University, Lafayette, Ind. 1902

LUEBBERS, R. H., Assistant Professor of Chemical Engineering, University of Missouri, Columbia, Mo. 1939

LUEBS, AUGUST A., Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. 1921

LUETH, IRVING B., Assistant Professor of Electrical Engineering, Pratt Institute, Brooklyn, N. Y. 1931

LUKE, CHARLES D., Professor and Head, Department of Chemical Engineering, Syracuse University, Syracuse, N. Y. **In military service** 1939

LUKENS, HIRAM S., Director, Department of Chemistry and Chemical Engineering, University of Pennsylvania, Philadelphia, Pa. 1935

LUNDBERG, GUSTAVE H., Instructor in Mathematics, Vanderbilt University, Nashville, Tenn. 1944
LUNDE, OTTO H., Professor and Head, Dept. of Aeronautical Engineering, University of Alabama, University, Ala. **In military service** 1940
LURIE, ARNOLD N., Head, Drawing Department, Tilden Technical High School, Chicago, Ill. 1933
LUTHER, H. B., Professor of Civil Engineering, University of Cincinnati, Cincinnati, O. 1914
LUTZ, SAMUEL G., Physicist, Naval Research Lab., 2043 38th St., S.E., Washington, D. C. 1939
LUZADDER, WARREN J., Assistant Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1943
LYNCH, W. S., Professor in Charge of Humanities, Cooper Union, New York City 1939
LYTLE, CHAS. W., Associate Professor of Industrial Engineering, New York University, New York City 1922
MABIE, HAMILTON H., Instructor in Industrial Engineering, Cornell University, Ithaca, N. Y. 1941
MACCULLOUGH, GLEASON H., Professor of Engineering Mechanics, Worcester Polytechnic Institute, Worcester, Mass. 1922
MACDONALD, JAMES K. L., Assistant Professor of Mathematics, Cooper Union, New York City 1940
MACDONALD, JAMES R., Assistant Professor of Chemical and Metallurgical Engineering, West Virginia University, Morgantown, W. Va. 1943
MACDONNELL, ROBERT B., Assistant Professor of Physics, Boston College, Boston, Mass. 1943
MACEDO, G. MORALES, Director of Industries in Peru, 205 Tupac Amaro, San Isidro, Lima, Peru 1940
MACFADYEN, K. A., Instructor in Mechanical Engineering, Newark College of Engineering, Newark, N. J. **In military service** 1941
MACHWART, GEORGE M., Associate Professor of Chemical Engineering, Michigan College of M. & T., Houghton, Mich. 1941
MACINTOSH, ALBERT N., Associate Professor of Geological Engineering, Michigan College of M. & T., Houghton, Mich. 1943
MACK, ALBERT J., Professor of Mechanical Engineering, Kansas State College, Manhattan, Kans. 1919
MACK, DAVID J., Assistant Professor of Chemical Engineering, University of Tennessee, Knoxville, Tenn. 1943
MACKAVANAGH, THOMAS J., Professor and Chairman, Dept. of Electrical Engineering, Catholic University of America, Washington, D. C. .. 1943
MACKAY, SCOTT, Professor of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1936
MACKENZIE, C. J., University of Saskatchewan, Saskatoon, Canada 1915
MACKEY, CHARLES O., Professor in charge of Mechanical Laboratory, Cornell University, Ithaca, N. Y. 1942
MACKICHAN, KEITH B., Assistant Professor of Electrical Engineering, Bucknell University, Lewisburg, Pa. 1943
MACKINNON, JOSEPH C., Registrar, Massachusetts Institute of Technology, Cambridge, Mass. 1939
MACLEAN, EDWARD A., Professor and Head, Dept. of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1937
MACLIN, EDWARD S., President, West Virginia Institute of Technology, Montgomery, W. Va. 1922
MACNAUGHTON, EDGAR, Professor of Mechanical Engineering, Tufts College, Medford, Mass. 1916

MACQUIGG, CHARLES E., Dean of Engineering College, Director, Engineering Experiment Station, The Ohio State University, Columbus, Ohio. (*First Vice President, 1942–43; Member of Council, 1939–40.*) 1937
MADDOCK, JOHN K., College Representative, John Wiley & Sons, Inc., 440 Fourth Ave., New York City 1943
MADSEN, HOWARD C., Manager, University Relations, Westinghouse E. & M. Co., Pittsburgh, Pa. 1943
MAGGI, AGUSTIN, Dean Facultad de Ingenieria, Universidad de la Republica, Montevideo, Uurgay, S. A. 1943
MAGNUSON, ELTON E., College Dept., Prentice Hall Inc., 721 Mt. Pleasant Ave., Ann Arbor, Mich. 1943
MAGOUN, F. ALEXANDER, Associate Professor of Human Relations, Massachusetts Institute of Technology, Cambridge, Mass. 1930
MAHANEY, JOHN P., Associate Professor of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1939
MAHIN, EDWARD G., Professor and Head, Dept. of Metallurgy, University of Notre Dame, Notre Dame, Ind. 1939
MAINARDI, POMPEY, Associate Professor of Mathematics, Newark College of Engineering, Newark, N. J. 1935
MAINS, LAURENCE P., Assistant Professor of Civil Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937
MAINS, ROBERT M., Engineer, Applied Physics Lab., The Johns Hopkins University, Baltimore, Md. 1943
MALAKOFF, HOWARD L., Research and Development Engineer, Chemicals Div., Cities Service Oil Co., Tallant, Okla. 1941
MALBY, HOWARD S., Special Courses Instructor, Douglas Aircraft Co., 2910 Arline Ave., Artesia, Calif. 1944
MALCOLM, W. L., Director, School of Civil Engineering, Cornell University, Ithaca, N. Y. 1934
MALE, CHARLES T., Instructor in Civil Engineering, Union College, Schenectady, N. Y. 1943
MALLETT, FRANK M., Production Design Engineer, Curtiss-Wright Corp., 53 Arcadia Ave., Columbus 2, Ohio 1944
MALLORY, DONALD D., Staff Member, Radiation Lab., Massachusetts Institute of Technology, Cambridge, Mass. 1941
MALLORY, WALTER F., Professor of Mechanical Engineering, University of Colorado, Boulder, Colo. 1944
MALTBY, LEON L., Instructor in Applied Mathematics, Syracuse University, Syracuse, N. Y. 1941
MANDERFIELD, NICHOLAS H., Professor of Mineral Dressing, Michigan College of M. & T., Houghton, Mich. 1937
MANEY, GEORGE A., Chairman, Dept. of Civil Engineering, Northwestern University, Evanston, Ill. 1938
MANGOLD, JOHN F., Associate Professor of Mechanics, Illinois Institute of Technology, Chicago, Ill. 1941
MANIFOLD, GEORGE O., Instructor in Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa. **In military service** 1939
MANN, CAROLL L., Professor and Head, Dept. of Civil Engineering, North Carolina State College, Raleigh, N. C. 1937
MANN, CHARLES A., Chief of Division and Professor of Chemical Engineering, University of Minnesota, Minneapolis, Minn. 1917
MANN, CLAIR V., Professor of Engineering Drawing, University of Missouri, Rolla, Mo. (*Member of Council, 1925–8.*) 1924
MANNING, HERBERT L., Head, Job Evaluation Dept., Pratt & Whitney Co., East Hartford, Conn. 1939

MANNING, MELVIN L., Associate Professor of Electrical Engineering, Director, High Voltage Research Lab., Cornell University, Ithaca, N. Y. 1940
MANSKY, CLARENCE B., Instructor in Mechanics, Cornell University, Ithaca, N. Y. 1943
MARA, HUBERT W., Associate Professor of Drawing and Mathematics, Norwich University, Northfield, Vt. 1939
MARCHANT, GUY B., Associate Professor of Electrical Engineering, Evansville College, Evansville, Ind. 1927
MARCO, SALVATORE M., Associate Professor of Mechanical Engineering, The Ohio State University, Columbus, Ohio 1937
MARCOUX, HELIODORE A., Assistant Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1944
MARIANI, RICHARD A., Professor of Mechanical Engineering, St. Rita High School, Chicago 36, Ill. 1943
MARIN, AXEL, Associate Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1941
MARIN, JOSEPH, Professor of Engineering Mechanics, The Pennsylvania State College, State College, Pa. 1931
MARKLE, E. W., Professor of Electrical Engineering, A. & M. College of Texas, College Station, Tex. 1923
MARKLE, GERALD E., Instructor in Mathematics, University of Detroit, Detroit, Mich. **In military service** 1941
MARKLEY, JAMES M., Apprentice Supervisor, Eastern Air Lines, Inc., 3150 S.W. 19th Terrace, Miami, Fla. 1943
MARKOWITZ, JESSE, Instructor in Drafting, College of the City of New York, New York City 1940
MARKS, MARY E., Librarian, University of Wyoming, Laramie, Wyo. ... 1944
MARLIES, CHARLES A., Assistant Professor of Chemical Engineering, College of the City of New York, New York City 1940
MARMO, E. JOSEPH, Assistant Professor of Engineering Mechanics, University of Nebraska, Lincoln, Nebr. 1940
MARQUIS, F. W., Professor and Chairman, Dept. of Mechanical Engineering, The Ohio State University, Columbus, Ohio. (*Member of Council, 1936–39.*) 1910
MARSHALL, OSCAR J., Associate Professor of Surveying and Geodesy, The Ohio State University, Columbus, Ohio 1940
MARSTON, ANSON, Dean of Engineering, Emeritus, Iowa State College, Ames, Ia. (*President, 1914–5; Treasurer, 1906–7; Member of Council, 1914–.*) **Fourteenth Recipient, Lamme Medal (1941).** ... 1894
MARSTON, GEORGE A., Assistant Professor of Civil Engineering, Massachusetts State College, Amherst, Mass. **In military service** 1938
MARTEENA, JERALD M., Dean, School of Engineering, A. & M. College, Greensboro, N. C. 1943
MARTIN, BRUCE W., Lecturer in General Engineering, University of Southern California, Los Angeles, Calif. 1933
MARTIN, CHARLES E., Instructor in Welding, Illinois Institute of Technology, Chicago, Ill. 1942
MARTIN, F. F., Industrial Relations Dept., Kimberly Clark Corp., Neenah, Wis. 1939
MARTIN, FRANK L., Professor of Physics, Pennsylvania Military College, Chester, Pa. 1938
MARTIN, JOSEPH J., Instructor in Chemical Engineering, University of Rochester, Rochester, N. Y. 1941

MARTIN, W. H., Professor of Mechanical Engineering, Oregon State College, Corvallis, Ore. 1913

MARTINEZ TORNEL, PEDRO, Director, Escuela Nacional de Ingenieros, Mexico, D. F., Mexico 1943

MASON, HIRAM R., Professor and Head, Dept. of Electrical Engineering, Southwestern Louisiana Institute, Lafayette, La. 1939

MASON, HOWARD W., Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1927

MASON, JESSE W., Professor and Head, Dept. of Chemical Engineering, Georgia School of Technology, Atlanta, Ga. 1935

MASON, WENDELL E., Associate Professor of Engineering, University of California at Los Angeles, Calif. 1939

MASSEY, JOE T., Instructor in Mechanical Engineering, North Carolina State College, Raleigh, N. C. **Service**. 1940

MASSON, HENRY J., Assistant Dean, Professor and Chairman, Dept. of Chemical Engineering, New York University, New York City 1935

MATHEWSON, CHAMPION H., Professor of Metallurgy, Yale University, New Haven, Conn. 1921

MATHIESEN, JOHN T., Instructor in Geography, Michigan College of M. & T., Houghton, Mich. 1944

MATSON, RANDOLPH, Project Engineer, Douglas Aircraft Co., Inc., 1110 Tedford Way, Oklahoma City, Okla. 1943

MATSON, RAY M., Professor and Head, Dept. of Mechanical Engineering, Southern Methodist University, Dallas, Texas 1937

MATSON, ROBERT C., Associate Professor of Civil and Mining Engineering, Michigan College of M. & T., Houghton, Mich. 1944

MATTHES, GEORGE F., Associate Professor of Electrical Engineering, Louisiana State University, University, La. 1935

MATZKE, ARTHUR E., Research Assistant in Civil Engineering, Columbia University, New York City 1936

MAUGH, LAWRENCE C., Assistant Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1940

MAURER, EDWARD R., Professor of Mechanics, (Emeritus) University of Wisconsin, Madison, Wis. (*Vice President, 1918–9; Member of Council, 1909–12.*) **Seventh Recipient Lamme Medal (1934).** 1897

MAURER, ROBERT L., Instructor in English, Oregon State College, Corvallis, Ore. **In military service** 1941

MAUTE, BERNHARD W., Instructor in Machine Design, U. S. Military Academy, West Point, N. Y. **In military service** 1941

MAVIS, FREDERIC T., Professor and Head, Dept. of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1929

MAXFIELD, DAVID K., Assistant Librarian, Cooper Union, New York City 1943

MAXFIELD, HAROLD A., Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. **In military service** 1925

MAXWELL, FRED R., JR., Professor of Electrical Engineering, University of Alabama, University, Ala. **In military service** 1934

MAY, JAMES W., Associate Professor of Mechanical Engineering, University of Kentucky, Lexington, Ky. 1938

MAYER, JOHN K., Associate Professor and Head, Dept. of Experimental Engineering, Tulane University, New Orleans, La. 1937

MAYROSE, HERMAN E., Professor of Engineering Mechanics, University of Detroit, Detroit, Mich. 1940

MCADAMS, WILLIAM H., Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1932

McAulay, Hubert J., Instructor in Mechanical Engineering, University of Detroit, Detroit, Mich. 1943
McCain, Dewey M., Professor and Head, Dept. of Civil Engineering, Mississippi State College, State College, Miss. 1933
McCandliss, L. C., Professor and Head, Dept. of Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. 1914
McCarthy, James A., Assistant Professor of Civil Engineering, University of Notre Dame, Notre Dame, Ind. 1939
McCaskey, A. E., Head, Dept. of Engineering, Marshall College, Huntington, W. Va. **In military service** 1936
McCauley, Roy B., Instructor in Metallurgy, Illinois Institute of Technology, Chicago, Ill. 1943
McClain, Fred H., Professor and Chairman, Dept. of Electrical Engineering, University of Denver, Denver, Colo. 1921
McClelland, E. H., Technology Librarian, Carnegie Library of Pittsburgh, Pittsburgh, Pa. 1912
McClintock, Edwin C., Instructor in English, University of Virginia, University, Va. 1939
McClinton, Arthur T., Assistant Professor of Electrical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1943
McClung, James D., Assistant Professor of Engineering Drawing, Alabama Polytechnic Institute, Auburn, Ala. 1943
McClure, John A., Professor of Industrial Management, University of Akron, Akron, Ohio 1943
McClure, Oscar E., Associate Professor of Physics and Electrical Engineering, Ohio University, Athens, Ohio 1937
McCollum, Arthur R., Supt., Bldgs. & Grounds, State Teachers College, Elizabeth City, N. C. 1943
McCombs, Glenn C., Assistant Professor of Engineering Drawing and Descriptive Geometry, Carnegie Institute of Technology, Pittsburgh, Pa. 1934
McConnell, Robert K., Instructor in Engineering Drawing, New York University, New York City. **In military service** 1942
McCormack, Harry, Professor and Director, Department of Chemical Engineering, Illinois Institute of Technology, Chicago, Ill. 1935
McCormack, Ralph H., Assistant Professor of Chemical Engineering, Pratt Institute, Brooklyn, N. Y. 1937
McCormick-Goodhart, Leander H., Instructor, Henry Ford Trade School, Grosse Point, Mich. 1944
McCoy, James E., Head, Dept. of Chemistry, Bluefield Junior College, Bluefield, Va. 1940
McCready, Donald W., Associate Professor of Chemical Engineering, University of Michigan, Ann Arbor, Mich. 1943
McCrumm, John D., Assistant Professor of Electrical Engineering, Swarthmore College, Swarthmore, Pa. 1936
McCuen, Glen W., Chairman, Dept. of Agricultural College, The Ohio State University, Columbus, Ohio 1943
McCullough, Frank M., Professor Emeritus, Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1910
McCully, Harry M., Professor and Head, Dept. of Drawing, Carnegie Institute of Technology, Pittsburgh, Pa. 1926
McCully, Harry M., Jr., Instructor in Graphics and Engineering Drawing, Princeton University, Princeton, N. J. 1939
McCurdy, Henry B., Editor and Assistant Manager, College Dept. Macmillan Company, 60 5th Avenue, New York City 1936

McDaniel, J. E., Professor and Director of Coöperative Courses, Georgia School of Technology, Atlanta, Ga. (*Member of Council, 1930–33.*) 1926
McDonald, Frederick J., Instructor in Engineering Drawing, St. Mary's College, Winona, Minn. 1944
McDonald, Philip B., Professor of English, New York University, University Heights, New York, N. Y. 1917
McDonald, Raymond N., Assistant Professor of Mechanical Engineering, Vanderbilt University, Nashville, Tenn. 1944
McElroy, D. Lee, Director, School of Mines, West Virginia University, Morgantown, W. Va. 1938
McEnany, Mike V., Instructor in Electrical Engineering, The Rice Institute, Houston, Texas 1943
McFarlan, Harold J., Assistant Professor of Geodesy and Surveying, University of Michigan, Ann Arbor, Mich. 1941
McFarland, James D., Associate Professor of Drawing, University of Texas, Austin, Texas 1938
McFarland, Reginald A., Professor and Head, Dept. of Civil Engineering Louisiana Polytechnic Institute, Ruston, La. 1939
McGaw, Alex J., Professor of Civil Engineering, University of Wyoming, Laramie, Wyo. 1944
McGehee, William, Associate Professor and Head, Dept. of Psychology, North Carolina State College, Raleigh, N. C. **In military service** 1941
McGivern, James G., Dean of Engineering, Gonzaga University, Spokane, Wash. 1936
McGrady, Denton D., Assistant Professor of Chemical and Metallurgical Engineering, Michigan State College, East Lansing, Mich. 1939
McGuire, John G., Associate Professor of Engineering Drawing, A. & M. College of Texas, College Station, Texas 1939
McIlroy, Malcolm S., Assistant Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1937
McIlvain, John M., Administrative Supervisor, Research and Development Dept., Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa. ... 1944
McIntosh, William G., Associate Professor of Mechanical Engineering, University of Toronto, Toronto, Canada 1943
McIntyre, Harry J., Professor of Mechanical Engineering, University of Washington, Seattle, Wash. 1939
McIntyre, John A., Instructor in Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 204 N. Beechwood, Catonsville 28, Md. ... 1943
McIntyre, Lewis W., Consulting Engineer, 6630 Woodwell St.; Lecturer, University of Pittsburgh, Pittsburgh, Pa. **In military service** 1919
McKean, James P., Associate Professor of General Engineering, Iowa State College, Ames, Iowa 1943
McKee, Edd R., Professor and Head, Department of Electrical Engineering, University of Vermont, Burlington, Vt. 1934
McKee, Harry L., Assistant Professor of Drawing and Descriptive Geometry, Carnegie Institute of Technology, Pittsburgh, Pa. 1938
McKee, Wayne S., Assistant Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1940
McKenry, Nell, Assistant Secretary, Society for the Promotion of Engineering Education, University of Pittsburgh, Pittsburgh, Pa. ***Assistant Secretary, 1918–*** **1923**
McKeon, Jesse C., Supervisor, Scholarships and Graduate Study, Westinghouse E. & M. Co., 306 Fourth Ave., Pittsburgh, Pa. 1944

McKergow, C. M., Professor of Mechanical Engineering, McGill University, Montreal, Canada. (*Member of Council, 1927–30.*) 1913
McKibben, Eugene G., Professor of Agricultural Engineering, Michigan State College, East Lansing, Mich. 1937
McKinney, James, Vice President and Educational Director, American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. 1943
McLain, Stuart, Assistant Professor of Chemistry, University of Arkansas, Fayetteville, Ark. **In military service** 1936
McLaughlin, Roland R., Associate Professor of Chemical Engineering, University of Toronto, Toronto, Ont. 1940
McLaurin, Banks, Professor of Civil Engineering, University of Texas, Austin, Texas 1927
McLean, William G., Engineer, New Products, Eastman Kodak Co., Rochester, N. Y. 1939
McLellan, Harvey J., Assistant Professor of Mechanical Engineering, University of Notre Dame, Notre Dame, Ind. 1943
McMaster, Allen S., Instructor in Electrical Engineering, University of Colorado, Boulder, Colo. 1931
McMillan, Fred O., Professor and Head, Dept. of Electrical Engineering, Oregon State College, Corvallis, Ore. 1932
McMillen, Elliott L., Associate Professor and Head, Dept. of Chemical Engineering, Lafayette College, Easton, Pa. 1938
McMinn, Bryan T., Professor of Mechanical Engineering, University of Washington, Seattle, Wash. 1939
McNair, Arthur J., Assistant Professor of Civil Engineering, University of Colorado, Boulder, Colo. 1935
McNair, J. Stuart, Instructor in Mathematics and Engineering Drawing, Canal Zone Junior College, Balboa, C. Z. 1943
McNear, William F., Instructor in Machine Design, Stevens Institute of Technology, Hoboken, N. J. 1943
McNeary, Matthew, Assistant Professor of Engineering Drafting, University of Maine, Orono, Me. 1937
McNeill, Walter H., Professor and Chairman, Dept. of Drawing, University of Texas, Austin, Texas 1935
McNew, John T. L., Professor and Head, Dept. of Civil Engineering, A. & M. College of Texas, College Station, Texas. **In military service** . 1937
McNown, William C., Professor and Head, Department of Civil Engineering, University of Kansas, Lawrence, Kansas 1935
McRee, Fitzhugh L., Professor of Civil Engineering, Texas Technological College, Lubbock, Texas 1938
Mead, Daniel W., Professor Emeritus, Civil Engineering, University of Wisconsin, Madison, Wis. 1908
Meade, Kenneth A., Director, Technical Employment, General Motors Corp., Detroit, Mich. 1940
Meadowcroft, Norman, Contract Administrator, Douglas Aircraft Co., Santa Monica, Calif. 1942
Meares, Jefferson S., Associate Professor of Physics, North Carolina State College, Raleigh, N. C. 1937
Medlin, John W., Instructor in Mechanical Engineering, University of Wisconsin, Madison, Wis. 1943
Meier, Otto, Assistant Professor of Electrical Engineering, Duke University, Durham, N. C. 1943
Meigs, Howard H., Assistant Professor of Mechanics, University of Alabama, University, Ala. 1943

MEIXELL, L. GRANVILLE H., Engineering Librarian, Columbia University, New York City 1942
MELVIN, HAROLD W., Dean of Students, Professor of English, Northeastern University, Boston, Mass. 1932
MEMORY, NICHOL H., Director of Admissions, Stevens Institute of Technology, Hoboken, N. J. 1936
MENDES DA ROCHA, PAULO DE MENEZES, Escola Polytechnica, de Sao Paulo, Sao Paulo, Brazil, S. A. 1943
MENDEZ PEREIRA, OCTAVIO, Rector, Universidad Nacional de Panama, Ancon, Panama, C. Z. 1943
MENOHER, WADE L., Instructor in Civil Engineering, University of Colorado, Boulder, Colo. 1943
MERRIAM, KENNETH G., Professor of Aero Mechanics, Worcester Polytechnic Institute, Worcester, Mass. (*Life Member.*) **In military service** 1925
MERRICK, CHARLES M., Industrial Engineer, Glenn L. Martin Co., Baltimore, Md. 1929
MERRILL, DONALD W., Assistant Professor of Drawing and Architecture, University of Arkansas, Fayetteville, Ark. **In military service** 1939
MERRITT, CLARENCE W., Assistant Professor of Ceramic Engineering, New York State College of Ceramics, Alfred, N. Y. 1937
MERRITT, HAROLD W., Associate Professor of Physics, Cooper Union, New York City 1927
MERRYFIELD, FRED, Associate Professor of Civil Engineering, Oregon State College, Corvallis, Ore. **In military service** 1938
MESERVE, GEORGE H., JR., Associate Professor of Drawing, Northeastern University, Boston, Mass. 1929
MESSERSMITH, CHARLES W., Associate Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1940
METCALF, ABBIE H., Librarian, Thayer School of Engineering, Dartmouth College, Hanover, N. H. 1942
METZENHEIM, HENRY H., Comptroller, Newark College of Engineering, Newark, N. J. 1926
MEYER, CARL F., Associate Professor of Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1937
MICHALOWICZ, JOSEPH C., Instructor in Electrical Engineering, Catholic University of America, Washington, D. C. 1944
MICKEY, CLARK E., Professor and Chairman, Dept. of Civil Engineering, University of Nebraska, Lincoln, Nebr. 1940
MIDDENDORF, HENRY Q., Assistant Professor of German. Polytechnic Institute of Brooklyn, Brooklyn, N. Y. **In military service** 1940
MIDDLEMISS, ROSS R., Associate Professor of Applied Mathematics, Washington University, St. Louis, Mo. 1944
MIDDLETON, EWEL V., Assistant Professor of Civil Engineering, Texas Technological College, Lubbock, Texas 1941
MILES, ERNEST P., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. **In military service** 1940
MILES, HENRY J., Associate Professor of Civil Engineering, University of Southern California, Los Angeles, Calif. 1938
MILES, JOHN C., Associate in Mechanical Engineering, University of Illinois, Urbana, Ill. 1939
MILLAR, A. V., Assistant Dean, Emeritus, University of Wisconsin, Madison, Wis. 1914
MILLARD, CLYDE I., Assistant Professor of Industrial Engineering, Cornell University, Ithaca, N. Y. 1938

MILLER, ALFRED L., Professor of Mechanics and Structures, University of Washington, Seattle, Wash. 1927
MILLER, BENJAMIN, Chairman, Division, Education and Basic Research, Institute of Gas Technology, Chicago, Ill. 1944
MILLER, CHARLES A., Assistant Professor of Civil Engineering, Michigan State College, East Lansing, Mich. 1937
MILLER, CLARK O., Associate Professor of Chemical Engineering, Case School of Applied Science, Cleveland, Ohio 1939
MILLER, EDWARD C., Instructor in Metallurgical Engineering, Purdue University, Lafayette, Ind. In military service 1938
MILLER, ERNEST F., Instructor in Physics, Pratt Institute, Brooklyn N. Y. 1943
MILLER, F. CLIFFORD, Associate Professor of Engineering Drawing, Iowa State College, Ames, Iowa 1934
MILLER, FORREST E., Associate Professor of Mathematics and Mechanics, University of Minnesota, Minneapolis, Minn. 1926
MILLER, FREDERIC H., Professor and Head, Dept. of Mathematics, Cooper Union, New York City 1941
MILLER, H. W., Professor of Mechanism and Engineering Drawing, University of Michigan, Ann Arbor, Mich. 1922
MILLER, JOHN B., Assistant Professor of Electrical Engineering, Bucknell University, Lewisburg, Pa. 1941
MILLER, JOHN G., Principal, Frank Wiggins Trade Evening School, Los Angeles, Calif. 1943
MILLER, JOSEPH, Supervisor, Laundry Chemicals, E. F. Drew & Co., Boonton, N. J. 1942
MILLER, LORIN G., Professor and Head, Dept. of Mechanical Engineering, Michigan State College, East Lansing, Mich. 1937
MILER, PERCIVAL F., Assistant Professor of Applied Mechanics, Virginia Polytechnic Institute, Blacksburg, Va. 1944
MILLER, WALTER H., Assistant Professor of Mechanical Engineering, University of Missouri, Columbia, Mo. 1944
MILLER, WILLIAM J., Professor and Head, Dept. of Electrical Engineering, University of Alabama, University, Ala. 1923
MILLER, WILLIAM T., Associate Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. 1930
MILLIGAN, WILLIAM E., Assistant Professor of Metallurgy, Yale University, New Haven, Conn. 1933
MILLINGTON, HOWARD G., Assistant Professor of Mathematics, University of Vermont, Burlington, Vt. 1929
MILLMAN, JACOB, Assistant Professor of Electrical Engineering, College of the City of New York, New York City (on leave M. I. T.) 1942
MILLS, GUY G., Lt. Col. Professor of Military Science and Tactics, The Pennsylvania State College, State College, Pa. 1943
MILLS, G. H., Assistant Professor of Electrical Engineering, Case School of Applied Science, Cleveland, Ohio. In military service 1926
MILLS, JOHN, Director of Publication, Bell Telephone Laboratories, Inc., 463 West St., New York City 1921
MILLS, MALCOLM E., Project Engineer, Wright Aeronautical Corp., 443 Prospect St., Glen Rock, N. J. 1944
MILLS, PETER J., Associate Professor of Physics, Director, Parmly Foundation for Auditory Research, Illinois Institute of Technology, Chicago, Ill. 1943
MINARIK, RUDOLPH G., Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y. 1932

MINER, DOUGLAS F., George Westinghouse Professor of Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. **In military service** 1938
MING, FREDERICK W., Assistant Professor of Mechanical Engineering, Brooklyn Polytechnic Institute, Brooklyn, N. Y. 1918
MINKLER, HAROLD L., Instructor in Technical Drawing, Illinois Institute of Technology, Chicago, Ill. 1942
MINNICH, JOHN H., Assistant Professor of Civil Engineering, Thayer School of Engineering, Dartmouth College, Hanover, N. H. 1942
MINSHALL, ROBERT E., Professor of Structural Engineering, The Pennsylvania State College, State College, Pa. 1921
MIRABELLI, EUGENE, Associate Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1935
MIRGAIN, FRANK C., Associate Professor of Civil Engineering, Rutgers University, New Brunswick, N. J. 1935
MITCHAM, JAMES T., Associate Professor of Engineering and Trades, North Texas Agricultural College, Arlington, Texas 1941
MITCHELL, FRANCIS E., Instructor in Civil Engineering, University of Arkansas, Fayetteville, Ark. 1942
MITCHELL, LOUIS, Dean and Professor of Civil Engineering, Syracuse University, Syracuse, N. Y. (*Member of Council, 1938–41.*) 1913
MITCHELL, WILLIAM H., Vice President, T. Y. Crowell Co., 432 Fourth Ave., New York City 1943
MITCHELL, WILLIAM L., Dean of Men, Head, Dept. of Mechanical Engineering, Louisiana Polytechnic Institute, Ruston, La. 1939
MITSCH, JOHN D., Associate Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1940
MOCHEL, MYRON G., Research Associate, Underwater Sound Laboratory, Harvard University, Cambridge, Mass. 1943
MOCK, CLIFTON O., Instructor in General Engineering, Purdue University, Lafayette, Ind. 1929
MOCKMORE, CHARLES A., Professor and Head, Dept. of Civil Engineering, Oregon State College, Corvallis, Ore. (*Member of Council, 1938–41.*) 1927
MOEN, WALTER B., Instructor in Mechanical Engineering, Pratt Institute, Brooklyn, N. Y. 1941
MOENCH, HERMAN A., Assistant Professor of Electrical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. **In military service** 1934
MOFFAT, GEORGE N., Associate Professor of Mechanical Engineering, The Ohio State University, Columbus, Ohio 1925
MOHN, PAUL E., Professor and Head, Dept., Mechanical Engineering, University of Buffalo, Buffalo, N. Y. 1938
MOLSTAD, MELVIN C., Professor of Chemical Engineering, University of Pennsylvania, Philadelphia, Pa. 1937
MONTAGUE, EDWIN N., Principal Budget Examiner, Bureau of the Budget, Executive Offices of the President, Washington, D. C. **In military service** 1939
MONTGOMERY, O. DUNCAN, Manager of Student Training, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1944
MONTILLON, GEORGE H., Professor of Chemical Engineering, University of Minnesota, Minneapolis, Minn. 1925
MONTROSE, KARL D., Assistant Chief Chemist, D. & R. G. W. R. R. Co., Denver, Colo. 1943
MONTZ, JOHN M., Associate Professor of Civil Engineering, The Ohio State University, Columbus, Ohio 1943

MOODY, ARTHUR M. G., Research Engineer, De Laval Steam Turbine Co., Trenton, N. J. 1936
MOODY, HOWARD W., Professor of Civil Engineering, Valparaiso University, Valparaiso, Ind. 1938
MOODY, LEWIS F., Professor of Hydraulic Engineering, Princeton University, Princeton, N. J. 1912
MOORE, ARTHUR D., Professor of Electrical Engineering, Head Mentor, University of Michigan, Ann Arbor, Mich. 1926
MOORE, EARL R., Instructor in Mechanical Engineering, University of Connecticut, Storrs, Conn. 1930
MOORE, EMMETT B., Associate Professor of Civil Engineering, State College of Washington, Pullman, Wash. 1936
MOORE, HOLLISTER, Staff Representative, Student Activities, Society of Automotive Engineers, Inc., 351 Morris Ave., Mountain Lakes, N. J. 1944
MOORE, H. F., Emeritus Research Professor of Engineering Materials, University of Illinois, Urbana, Ill. 1905
MOORE, KENNETH H., Assistant Professor of Physics, Rensselaer Polytechnic Institute, Troy, N. Y. 1944
MOORE, MARK B., Assistant Professor of Mechanical Engineering, Swarthmore College, Swarthmore, Pa. 1938
MOORE, ROBERT F., Personnel Director, Columbia University, New York City 1944
MOORE, WARREN C., Supervisor, ESMWT, University of Alabama, University, Ala. 1943
MOOSE, PERRY E., Assistant Professor of Engineering Drawing, North Carolina State College, Raleigh, N. C. **In military service** 1937
MORE, CHAS. C., Professor of Structural Engineering, University of Washington, Seattle, Wash. (*Member of Council, 1919–22.*) 1901
MOREHOUSE, J. STANLEY, Dean of Engineering, Professor of Mechanical Engineering, Villanova College, Villanova, Pa. 1935
MOREHOUSE, THEODORE C., Editor-in-Chief, College Dept., Macmillan Co., 60 5th Ave., New York City 1936
MORELAND, EDWARD L., Dean of Engineering, Massachusetts Institute of Technology, Cambridge, Mass. (*Vice President, 1940–41.*) 1934
MOREY, CHARLES W., President, Chicago Technical College, 2000 So. Michigan Ave., Chicago, Ill. 1925
MORGAN, JEROME J., Professor of Chemical Engineering, Columbia University, New York City 1925
MORGAN, JESSE R., Dean of the Faculty, Colorado School of Mines, Golden, Colo. 1927
MORGAN, JOHN C., Assistant Professor of Chemical Engineering, Northeastern University, Boston, Mass. 1940
MORGAN, MILLETT G., Research and Development Engineer, Submarine Signal Co., 160 State St., Boston 9, Mass. 1941
MORGAN, ROBERT B., 141 Gillette Ave., Sayville, N. Y. 1942
MORGAN, STEWART S., Professor of English, A. & M. College of Texas, College Station, Texas 1938
MORGAN, THEODORE H., Professor and Head, Dept. of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. (Assistant Director, ESMWT, Washington, D. C.) (*Member of Council, 1935–38.*) 1927
MORGEN, RALPH A., Assistant Director, Engineering and Industrial Experiment Station, University of Florida, Gainesville, Fla. 1938
MORKOVIN, DIMITRY, Associate in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1943

MORLEY, RAYMOND K., Professor of Mathematics, Worcester Polytechnic Institute, Worcester, Mass. 1922
MORRIS, CLYDE T., Professor of Civil Engineering, The Ohio State University, Columbus, Ohio 1907
MORRIS, FREDERICK C., Assistant Professor of Civil Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1941
MORRIS, HAROLD, Instructor in Engineering Drawing, Manhattanville Junior High School, New York City 1941
MORRIS, HENRY M., Instructor in Civil Engineering, The Rice Institute, Houston, Texas 1942
MORRIS, SAMUEL B., General Manager and Chief Engineer, Dept. of Water and Power, Los Angeles, Calif. 1935
MORRISON, EDMUND, Assistant Professor of English, University of British Columbia, Vancouver, B. C. 1940
MORRISON, HOMER R., Assistant Manager, General Pub. Dept., Union Carbide and Carbon Corp., 30 East 42nd St., New York City 1944
MORRISON, ROGER L., Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich. 1925
MORSE, JAMES L., Mechanical and Structural Engineer, U. S. Bureau of Reclamation, 1210 Ogden St., Denver, 3, Colo. 1910
MORSE, REED F., Associate Professor of Civil Engineering, Kansas State College, Manhattan, Kansas 1929
MORTLAND, JAMES A., Assistant Professor of Engineering Drawing, University of Tampa, Tampa, Fla. 1943
MORTON, PAUL L., Assistant Professor of Electrical Engineering, University of California, Berkeley, Calif. 1939
MORTON, ROSCOE W., Professor and Head, Dept. of Mechanical Engineering, University of Tennessee, Knoxville, Tenn. (*Member of Council, 1936–39.*) 1929
MOSER, KENNETH J., Assistant Professor of Mechanical Engineering, Stevens Institute of Technology, Hoboken, N. J. 1939
MOSS, HELEN J., Librarian, Engineering Library, Yale University, New Haven, Conn. .... 194?
MOSSMAN, THIRZA A., Assistant Professor of Mathematics, Kansas State College, Manhattan, Kans. 1944
MOTA, CALOR C., Professor and Head, Dept. of Civil Engineering, University of Porto Rico, Mayaguez, P. R. 1925
MOTT, WILLIAM E., Director Emeritus, Carnegie Institute of Technology, 315 Wood St., Burlington, N. J. (*Member of Council, 1917–20.*) .. 1907
MOULTON, RALPH W., Assistant Professor of Chemical Engineering, University of Washington, Seattle, Wash. 1944
MOYER, JAMES A., Director, Division of University Extension, Massachusetts Department of Education, Boston, Mass. 1904
MOYER, RALPH A., Research Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa 1929
MOYNIHAN, JOHN R., Professor of Engineering Materials, Cornell University, Ithaca, N. Y. 1939
MUCKENHOUPT, CARL F., Professor and Head, Department of Physics, Northeastern University, Boston, Mass. 1937
MUELLER, GEORGE V., Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1926
MUHLENBRUCH, CARL W., Assistant Professor of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1943
MUIR, ROY C., Vice President in Charge of Engineering, General Electric Co., Schenectady, N. Y. 1940

MULLEN, C. F., Professor of Physics, Siena College, Loudonville, N. Y. .. 1943
MULLINS, B. F. K., Assistant Professor of Engineering Drawing, A. & M. College of Texas, College Station, Texas 1938
MUMFORD, CAREY G., Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1937
MUMMERT, HAROLD B., Assistant Professor of Engineering Valparaiso University, Valparaiso, Ind. 1944
MUNDEL, MARVIN E., Assistant Professor of Industrial Engineering, Purdue University, Lafayette, Ind. 1941
MUNDT, AUGUST J., Personnel Director of Engineering, Western Union Telegraph Co., 60 Hudson St., New York City 1942
MUNOZ, AUGUSTO A., Civil Engineer, Catholic University of Chile, Santiago, Chile, S. A. 1943
MUNRO, GEORGE W., Professor of Thermodynamics, Retired, Purdue University, Lafayette, Ind. 1915
MUNSON, THURMOND A., Professor of Hydraulic Engineering, A. & M. College of Texas, College Station, Texas. **Service** 1938
MURDICHIAN, KARMY, Instructor in Civil Engineering, Virginia Polytechnic Institute, Norfolk, Va 1942
MURDOUGH, J. H., Professor and Head, Dept. of Civil Engineering, Texas Technological College, Lubbock, Texas 1926
MURPHY, ALBERT J., Staff Supervisor, Student Training, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1944
MURPHY, EUGENE F., Instructor in Mechanical Engineering, University of California, Berkeley, Calif. 1939
MURPHY, GLENN, Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1929
MURPHY, JOHN W., Engineer in charge of Engineering Training, Radio Div., Western Electric Co., Kearny, N. J. 1944
MURPHY, LINDON J., Associate Professor (Municipal Engineer) Engineering Extension Service, Iowa State College, Ames, Iowa 1930
MURPHY, NELSON F., Assistant Professor of Chemical Engineering, Syracuse University, Syracuse, N. Y. 1941
MURRAY, WILLIAM A., Professor and Head, Dept. of Electrical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1935
MYERS, FRANK E., Assistant Professor of Physics, New York University, New York City. **In military service** 1938
MYERS, HOWARD D., Associate Professor of Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. 1922
MYKLESTAD, NILS O., Assistant Professor of Machine Design, Illinois Institute of Technology, Chicago, Ill. **In military service** 1939
MYLREA, THOMAS D., Professor of Civil Engineering, University of Delaware, Newark, Del. 1935
NACHAZEL, JULIUS T., Assistant Professor of Mathematics, Michigan College of M. & T., Houghton, Mich. 1944
NACHMAN, HENRY L., Professor of Thermodynamics, Illinois Institute of Technology, Chicago, Ill. 1941
NAETER, ALBRECHT, Professor and Head, Department of Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1924
NAGEL, ROBERT H., Southern Railway, Knoxville, Tenn. 1944
NAHIKIAN, HOWARD M., Assistant Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1937
NARBUTOVSKIH, PAUL, Engineer, Westinghouse E. & M. Co., Sharon, Pa. 1944

NARMORE, PHIL B., Assistant to the Dean, Professor of Engineering Drawing and Mechanics, Georgia School of Technology, Atlanta, Ga. **In military service** .. 1934
NASH, C. A., Associate Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1913
NASH, PHILLIP C., President, University of Toledo, Toledo, Ohio 1921
NASH, THOMAS L., Comdr. U. S. Navy, Bureau of Ships, Washington, D. C. **In military service** .. 1938
NEAL, HENRY P., Associate Professor of Engineering Drawing, Mississippi State College, State College, Miss. 1941
NEEDY, JOHN A., Director of Technology and Engineering Education, Evansville College, Evansville, Ind. 1919
NELSON, ALFRED L., Professor and Head, Dept. of Mathematics, Wayne University, Detroit, Mich. 1939
NELSON, DELMAR W., Associate Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis. 1929
NELSON, ERIC W., 356 Millburn Ave., Millburn, N. J. 1939
NELSON, PAUL H., Assistant Professor of Electrical Engineering, University of Connecticut, Storrs, Conn. 1942
NELSON, WILBUR C., Professor and Head, Dept. of Aeronautical Engineering, Iowa State College, Ames, Iowa 1943
NELSON, WILBUR L., Professor and Head, Dept. of Petroleum Refining, University of Tulsa, Tulsa, Okla. 1941
NETHHEN, HARLEY J., Professor of Electrical Engineering, Louisiana Polytechnic Institute, Ruston, La. 1939
NETTLETON, E. B., Associate Professor of Drawing and Descriptive Geometry, Carnegie Institute of Technology, Pittsburgh, Pa. 1937
NEUGEBAUER, GEORGE H., Assistant Professor of Machine Design, Cooper Union, New York City 1938
NEVILLE, HARVEY A., Professor and Head, Dept. of Chemistry and Chemical Engineering, Lehigh University, Bethlehem, Pa. 1943
NEW, JOHN C., Instructor in Civil Engineering, University of Missouri, Columbia, Mo. 1943
NEWCOMBE, JAMES A., Professor of Metallurgical Engineering, University of Toronto, Toronto, Canada 1943
NEWELL, HOBART H., Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1925
NEWMAN, ALBERT B., Dean, School of Technology, Professor of Chemical Engineering, College of the City of New York, New York City 1929
NEWMAN, MARCEL K., Research and Development Engineer, Walter Kidde & Co., Inc., Belleville, N. J. 1937
NEWMARK, NATHAN M., Research Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1943
NEWSOM, CARROLL V., Professor of Mathematics, Oberlin College, Oberlin, Ohio 1943
NEWTON, DUDLEY, Professor and Head, Dept. of Civil Engineering, Wayne University, Detroit, Mich. 1938
NICHOLS, BEN H., Associate Professor of Electrical Engineering, Oregon State College, Corvallis, Ore. **In military service** 1930
NICHOLS, CLYDE R., Dean of Engineering, Arkansas Polytechnic Institute, Russellville, Ark. 1936
NICHOLS, M. STARR, Professor of Sanitary Chemistry, University of Wisconsin, Madison, Wis. 1943
NICHOLSON, HUGH P., President, Chestnut Hill Zinc Co., Galena, Ill. 1940
NICHOLSON, JOHN B., Librarian, Fenn College, Cleveland, Ohio 1944

NICHOLSON, NATALIE N., Librarian, Graduate School of Engineering, Harvard University, Cambridge, Mass. 1941
NICKELSEN, JOHN M., Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1940
NIELSEN, PAUL E., Associate Professor of Physics, Newark College of Engineering, Newark, N. J. 1943
NIESSINK, THOMAS, Instructor in Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1943
NIGHTINGALE, WINTHROP E., Director of Coöperative Work, Northeastern University, Boston, Mass. 1925
NIKIRK, FRANK A., Civil Engineer, Thew Shovel Co., Lorain, Ohio 1943
NILES, ALFRED S., Professor of Aeronautical Engineering, Stanford University, Stanford University, Calif. 1940
NILMEIER, HERBERT P., Instructor in Civil Engineering, University of California, Berkeley, Calif. 1944
NILSON, ARTHUR R., Director and Chief Instructor, Nilson Radio School, 51 East 42nd St., New York, 17, N. Y. 1942
NIMS, ALBERT A., Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. 1928
NOBLE, GILBERT W., Associate Professor of Petroleum Engineering, Missouri School of Mines & Metallurgy, Rolla, Mo. 1940
NOFFSINGER, JOHN S., Director, National Council of Technical Schools, 839 17th St., N.W., Washington, D. C. 1944
NOLD, HARRY E., Professor and Chairman, Dept. of Mine Engineering, The Ohio State University, Columbus, Ohio 1937
NOLLAU, LOUIS E., Professor of Drawing, University of Kentucky, Lexington, Ky. 1928
NORDENHOLT, GEORGE F., Editor, *Product Engineering*, McGraw-Hill Publishing Co., 330 West 42nd St., New York 18, N. Y. 1931
NORDLING, CARL G. A., Assistant Professor of Mathematics, University of Connecticut, Storrs, Conn. 1942
NORMAN, CARL A., Professor of Machine Design, The Ohio State University, Columbus, O. 1918
NORMAND, HAL C., Instructor in Civil Engineering, Texas Technological Institute, Lubbock, Texas 1938
NORRIS, BOB, Assistant Professor of Electrical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1943
NORRIS, EARLE B., Dean of Engineering, Virginia Polytechnic Institute, Blacksburg, Va. (*Member of Council, 1924–7.*) 1907
NORRIS, FERRIS W., Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebr. 1925
NORTHCOTT, JOHN A., JR., Professor of Electrical Engineering, University of Notre Dame, Notre Dame, Ind. 1938
NORTHRUP, MILES G., Professor and Head, Dept. of Electrical Engineering, University of Louisville, Louisville, Ky. 1943
NORTHRUP, RALPH T., Professor and Head, Dept. of Engineering Drawing, Wayne University, Detroit, Mich. 1934
NORTON, FREDERICK H., Associate Professor of Ceramics, Massachusetts Institute of Technology, Cambridge, Mass. 1937
NORTON, PAUL T., JR., Professor and Head, Dept. of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. (*Member of Council, 1934–37.*) 1926
NORWOOD, JOHN N., President, Alfred University and New York State College of Ceramics, Alfred, N. Y. 1941

NOTHSTINE, LEO V., Senior Engineer, Ford Motor Co., Willow Run Plant, Dearborn, Mich. 1940
NOWICKI, ALBERT L., Assistant Professor of Civil Engineering, Marquette University, Milwaukee, Wis. **In military service** 1938
NUDD, PHILIP, Assistant Professor of Electrical Engineering, Cooper Union, New York City 1939
NUDD, WILLARD E., Registrar; Associate Professor of Engineering Drawing, Case School of Applied Science, Cleveland, O. 1923
NUGENT, HOMER H., Professor and Head, Dept. of English, Rensselaer Polytechnic Institute, Troy, N. Y. 1937
NULSEN, WILLIAM B., Associate Professor of Electrical Engineering, University of New Hampshire, Durham, N. H. 1936
NUNAN, JAMES K., Assistant Professor of Electrical Engineering, Assistant to the Dean of Engineering, University of Southern California, Los Angeles, Calif. 1940
NYE, EDWIN P., Mechanical Engineer, NACA, Hampton, Va. 1942
NYLAND, WAINO, Associate Professor of English, University of Colorado, Boulder, Colo. 1936
OAKEY, JOHN A., Associate Professor of Civil Engineering, Villanova College, Villanova, Pa. 1936
OBERMAN, LEROY, Western Pipe & Steel Corp., Los Angeles, Calif. 1943
OBERT, EDWARD F., Associate Professor of Mechanical Engineering, Northwestern Technological Institute, Evanston, Ill. 1940
OBOUKHOFF, NICHOLAS M., Research Professor of Electrical Engineering and Mathematics, Oklahoma A. & M. College Stillwater, Okla. 1943
O'BRIEN, ELWIN J., Associate Professor of Electrical Engineering, University of North Dakota, Grand Forks, N. D. 1938
O'BRIEN, EUGENE W., Vice President, W. R. C. Smith Pub. Co., 1020 Grant Bldg., Atlanta, Ga. 1935
O'BRIEN, MORROUGH P., Dean, College of Engineering, University of California, Berkeley, Calif. 1939
OCKERBLAD, ANDREW M., Associate Professor of Applied Mechanics, University of Kansas, Lawrence, Kansas 1935
O'CONNELL, DANIEL J., Associate Professor of Civil Engineering, Manhattan College, New York, N. Y. 1931
O'CONNOR, GUSTAVUS R., Head, Dept. of Engineering, United States Coast Guard Academy, New London, Conn. 1941
O'CONNOR, JOHNSON, Director, Johnson O'Connor Research Foundation, 11 E. 62d St., New York, 21, N. Y. 1931
OCVIRK, FRED W., Instructor in Aeronautical Engineering, Cornell University, Buffalo, N. Y. 1942
ODEN, E. CLARENCE, Process Engineer, Cities Service Refining Corp., Lake Charles, La. 1941
O'DONNELL, RAYMOND, Professor of Hydraulics and Sanitary Engineering, The Pennsylvania State College, State College, Pa. 1934
O'FARRELL, JOHN B., Technology Librarian, College of the City of New York, New York City 1941
O'FIEL, CHARLES G., Chief, Airways Engineering Branch, C.A.A., 1108 Fifth Ave., Fort Worth, Texas 1943
OGBURN, S. CICERO, JR., Manager, Research and Development Dept., Pennsylvania Salt Mfg. Co., Philadelphia, Pa. (*Member of Council, 1935–8.*) 1928
OGLESBY, JOHN L., Instructor in Chemical Engineering, University of Tennessee, Knoxville, Tenn. 1943

OHLSEN, EDWARD H., Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1943
OLDENBURGER, RUFUS, Professor of Mathematics, Illinois Institute of Technology, Chicago, Ill. 1942
O'LEARY, ALLAN M., Instructor in General Engineering and Mathematics, University of Dayton, Dayton, Ohio 1941
OLESON, CALVIN C., Acting Head, Associate Professor of Civil Engineering, South Dakota State College, Brookings, S. D. In military service 1938
OLIN, HUBERT L., Professor of Chemical Engineering, State University of Iowa, Iowa City, Iowa 1936
OLITT, ARNOLD, Associate in Civil Engineering, University of California, Berkeley, Calif. 1944
OLIVER, JOHN C., Registrar, Association of Professional Engineers, Vancouver, B. C., Canada 1938
OLIVER, WILLIAM A., Associate Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1928
OLMSTED, CHARLES T., Associate Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. 1929
OLNEY, RAYMOND, Secretary-Treasurer, American Society of Agricultural Engineers, P.O. Box 229, St. Joseph, Mich. 1943
OLSEN, GERNER A., Research Director, Santee Mills, Bamburg, S. C. (323 Lincoln Ave., Highland Park, N. J.) 1936
OLSEN, JOHN C., Professor of Chemical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1930
OLSEN, LEROY, Instructor in Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1940
OLSON, OSCAR A., Professor and Head, Dept. of Engineering Drawing, Iowa State College, Ames, Ia. 1915
ONDRA, OTAKAR, Instructor in Civil Engineering, Manhattan College, New York City 1943
ONUF, BRONIS R., Instructor in Mechanical Engineering, Yale University, New Haven, Conn. 1943
OPDYKE, JOHN B., Engineer, Lago Oil and Transport Co., Ltd., Aruba, Curaco 1937
ORDUNG, PHILIP F., Instructor in Electrical Engineering, Yale University, New Haven, Conn. In military service 1943
ORMONDROYD, JESSE, Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. Service 1939
O'ROURKE, CHARLES E., Professor of Structural Engineering, Cornell University, Ithaca, N. Y. 1941
O'ROURKE, FRANK J., Instructor in Sheet Metal, Quincy Trade School, 35 Pontiac St., Quincy, Mass. 1942
ORR, JOSEPH A., Acting Professor of Civil Engineering, A. & M. College of Texas, College Station, Texas 1943
ORTH, HERBERT D., Professor of Drawing and Descriptive Geometry, University of Wisconsin, Madison, Wis. 1910
OSBORN, FRANCIS C., Head, Industrial Arts Dept., Chairman of Engineering Curriculum, Arizona State Teachers College, Flagstaff, Ariz. ... 1934
OSBORN, JOHN R., Instructor in Civil Engineering, A. & M. College of Texas, College Station, Texas 1940
OSBORN, ROBERT E., Instructor in Electrical Engineering, Cornell University, Buffalo, N. Y. 1943
OSBORNE, HAROLD S., Assistant Chief Engineer, American Tel. & Tel. Co., 195 Broadway, New York City 1935

OSBORNE, SHERIDAN, Assistant Professor of Engineering Drawing, Wayne University, Detroit, Mich. 1940
OSBURN, ORREN E., Assistant Professor of Electrical Engineering, Washington State College, Pullman, Wash. 1932
O'SHAUGHNESSY, LOUIS, Professor and Head, Dept. of Applied Mechanics, Director of Graduate Studies, Virginia Polytechnic Institute, Blacksburg, Va. 1912
OSTERHOF, GERARD G., Professor and Head, Dept. of Chemistry, South Dakota State School of Mines, Rapid City, S. D. 1940
OSTROM, CHARLES D. V., Instructor in Civil Engineering, University of California; 3024 Clay St., San Francisco, Calif. **In military service** 1939
OSWALD, CHARLES T., Chairman of Engineering, Scranton-Keystone Junior College, La Plume, Pa. 1942
OTHMER, DONALD F., Professor and Head, Dept. of Chemical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1937
OTHMER, MURRAY E., Associate Professor of Chemical Engineering, Tufts College, Medford, Mass. 1942
OTT, PERCY W., Professor and Chairman, Dept. of Mechanics, The Ohio State University, Columbus, Ohio 1925
OTTER, JOHN V., Engineering and Industrial Consultant, Boise, Idaho 1929
OTTO, LOUIS L., Assistant Professor of Automotive Engineering, Cornell University, Ithaca, N. Y. 1941
OVERCASH, RAY L., Route 1, Front Royal, Va. 1942
OWEN, HALSEY F., Associate Professor of Industrial Engineering, Purdue University, Lafayette, Ind. 1940
OWEN, SAMUEL P., Assistant Professor of General Engineering, Rutgers University, New Brunswick, N. J. 1943
OWENS, FREDERICK W., Professor and Head, Dept. of Mathematics, The Pennsylvania State College, State College, Pa. 1926
OWENS, RALPH G., Supervisor of Thermodynamics, Armour Research Foundation, 35 West 33rd St., Chicago, Ill. 1944
OXNARD, HORACE W., Instructor in Engineering Drawing, Ricker Classical Institute and Junior College, Houlton, Maine 1943
PADDOCK, RUSSELL G., Professor and Head, Dept. of Mechanical Engineering, University of Arkansas, Fayetteville, Ark. 1931
PAFFENBARGER, RALPH S., Professor and Chairman, Dept. of Engineering Drawing, The Ohio State University, Columbus, Ohio 1932
PAINE, ELLERY B., Professor and Head, Dept. of Electrical Engineering, University of Illinois, Urbana, Ill. 1911
PAINTER, ROBERT J., Assistant to the Secretary, American Society for Testing Materials, 260 S. Broad St., Philadelphia, 2, Pa. 1941
PALMER, DELOS M., Plant Engineer, American Propeller Corp., 19979 Renfrew Dr., Detroit, Mich. 1933
PALMER, HARLAN B., Professor of Electrical Engineering, University of Colorado, Boulder, Colo. 1939
PALMER, HERALD K., Assistant Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1930
PALMER, STANLEY G., Dean, Engineering College, University of Nevada, Reno, Nev. 1937
PALMERTON, LEIGHTON R., Director of Student Personnel, South Dakota State School of Mines, Rapid City, S. D. 1940
PALSGROVE, GRANT K., Professor of Hydraulic Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1918
PANUSKA, FRANK C., Administrative Assistant, Stuyvesant High School, New York City 1937

PARÉ, EUGENE G., Instructor in Engineering Drawing, Tufts College, Medford, Mass. 1943
PARENT, JOSEPH D., Research Associate, Institute of Gas Technology, Chicago, Ill. 1943
PARK, C. W., Professor of English, College of Engineering and Commerce, University of Cincinnati, Cincinnati, O. (*Member of Council, 1932–35.*) 1915
PARK, H. V., Associate Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1938
PARK, JOHN C., Professor of Highway Engineering, University of Arizona, Tucson, Ariz. 1931
PARKER, ERI B., Associate Professor of Mechanical Engineering, State College of Washington, Pullman, Wash. 1926
PARKER, J. C., Vice President, Consolidated Edison Co. of New York, 4 Irving Place, New York City 1916
PARKER, NORMAN A., Professor and Head, Dept. of Mechanical Engineering, University of Colorado, Boulder, Colo. 1941
PARKER, S. THOMAS, Instructor in Mathematics, University of Louisville, Louisville, Ky. 1943
PARKER, WALTER H., Professor of Mining, University of Minnesota, Minneapolis, Minn. 1925
PARKINSON, LESLIE R., Head, Dept. of Aeronautical Engineering, North Carolina State College, Raleigh, N. C. **In military service** 1937
PARKS, FRED C., Vice President, Parks Air College Inc., East St. Louis, Ill. 1943
PARKS, JOHN M., Instructor in Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1943
PARKS, WILBUR H., Chairman, Dept. of Mechanical Engineering, University of Denver, Denver, Colo. 1942
PARR, JOHNSTONE, Director of Engineering English, University of Alabama, Tuscaloosa, Ala. 1941
PARROTT, ALICE A., Head, Department of English, Tri-State College, Angola, Ind. 1932
PARSONS, ARTHUR B., Secretary, American Institute of Mining & Metallurgical Engineers, 33 West 39th Street, New York City 1939
PARSONS, H. MERLE, Secretary and Registrar, South Dakota State School of Mines, Rapid City, S. D. 1940
PARTLO, F. L., Professor and Head, Dept. of Physics, Michigan College of M. & T., Houghton, Mich. 1939
PATRICK, KENNETH R., Commanding Officer, RCAF, No. 5 Radio School, Clinton, Ont., Canada 1943
PATTEN, LAWTON M., Instructor in Engineering Drawing, New York University, New York City. **In military service** 1938
PATTEN, W. E., Assistant Hydraulic Engineer, Water Resources Branch, U. S. Geological Survey, So. Boston, Va. 1915
PATTERSON, L. L., Dean of Engineering, Professor of Electrical Engineering, Mississippi State College, State College, Miss. 1915
PATTERSON, ROBERT A., Professor and Head, Dept. of Physics, Rensselaer Polytechnic Institute, Troy, N. Y. 1937
PATTERSON, STANLEY, Instructor in Mechanical Engineering, Supt. Building and Grounds, Southern Methodist University, Dallas, Texas 1940
PATTERSON, WILLIAM E., Area Supervisor, ESMWT, University of Alabama, University, Ala. 1943
PATTISON, FLOYD, Professor of Mechanical Engineering, Extension Division, Kansas State College, Manhattan, Kansas 1934

PAUL, C. E., Professor Emeritus of Mechanics, Illinois Institute of Technology, Chicago, Ill. 1907
PAUL, EDWIN W., Instructor in Engineering Drawing, University of Louisville, Louisville, Ky. 1943
PAULSEN, FRIDTJOF, Instructor in Mathematics and Engineering, San Mateo Junior College, San Mateo, Calif. 1935
PAUSTIAN, RAYMOND G., Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa 1930
PAVIAN, HENRY C., Assistant Professor of Aeronautical Engineering, University of Pittsburgh, Pittsburgh, Pa. **In military service** 1935
PAYNE, WILLIAM M., Research Engineer, Linde Air Products Co., Tonawanda, N. Y. 1941
PAYROW, HARRY G., Associate Professor of Sanitary Engineering, Lehigh University, Bethlehem, Pa. 1930
PEARCE, CLINTON E., Professor and Head, Dept. of Machine Design, Kansas State College, Manhattan, Kansas 1937
PEARCE, F. W., Head, Dept. of General Engineering, Northern Montana College, Havre, Mont. 1938
PEARL, WILLIAM A., Vice President in charge of Manufacturing, Whiting Corp., Harvey, Ill. 1935
PEARSON, DONALD S., Design Engineer, Westinghouse E. & M. Co., Lima, Ohio 1939
PEARSON, JOHN E., Instructor in General Engineering Drawing, University of Illinois, Urbana, Ill. **In military service** 1942
PEASE, ED. M. J., Professor and Head, Dept. of Mathematics and Electrical Engineering, Rhode Island State College, Kingston, R. I. 1937
PECK, GEORGE V., Assistant Professor of Civil Engineering, Stanford University, Stanford University, Calif. 1943
PECK, HARRIET R., Librarian, Rensselaer Polytechnic Institute, Troy, N. Y. 1911
PECK, JOHN S., Associate Professor of Civil Engineering, Director, Materials Testing Lab., College of City of New York, New York, N. Y. 1931
PECK, RALPH E., Assistant Professor of Chemical Engineering, Illinois Institute of Technology, Chicago, Ill. 1941
PEEBLES, JOHN B., Chairman, Division of Engineering, Emory University, Atlanta, Ga. 1943
PEEBLES, JAMES C., Dean of Engineering, Illinois Institute of Technology, Chicago, Ill. 1927
PEERY, DAVID J., Professor and Head, Dept. of Aeronautical Engineering, The Pennsylvania State College, State College, Pa. 1938
PEET, J. C., Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. 1923
PEGADO, HENRIQUE, Director, Escola de Engenharia, Instituto MacKenzie, Sao Paulo, Brazil, S. A. 1943
PEGRAM, GEORGE B., Professor of Physics, Dean of Graduate Faculties, Columbia University, New York, N. Y. (*President, 1925–6; Vice President, 1924–5; Member of Council, 1924–.*) 1918
PEIRCE, GEORGE R., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. 1939
PENCE, W. D., Consulting Engineer, Room 1947, 120 South La Salle Street, Chicago, Ill. 1895
PENDER, HAROLD, Dean, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. (*Member of Council, 1924–7.*) 1909

PENDRAY, G. EDWARD, Assistant to President, in charge of Public Relations and Education, Westinghouse E. & M. Co., New York and Pittsburgh, Pa. 1942
PENN, JOHN C., Professor of Civil Engineering, Illinois Institute of Technology, Chicago, Ill. 1915
PERETTI, ETTORE A., Assistant Professor of Metallurgy, Columbia University, New York City 1944
PEREZ, LAWRENCE, Associate Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. 1933
PERKINS, DONALD L., Professor and Head, Dept. of Mechanical Engineering, Wayne University, Detroit, Mich. 1930
PERKINS, HAROLD C., Assistant Professor of Mechanics, Cornell University, Ithaca, N. Y. 1934
PERREIRA, DULCIDIO, Universidad do Brazil, Rio de Janeiro, Brazil, S. A. 1943
PERRONE, SAVIOUR A., Instructor in Customer Engineering, International Business Machine Corp., Endicott, N. Y. 1943
PERRY, JOHN E., Assistant Professor of Railroad Engineering, Cornell University, Ithaca, N. Y. 1922
PERRY, JOHN H., Technical Investigator, du Pont de Nemours & Co., Wilmington, Del. 1939
PERRY, JOHN P. H., Vice President, Turner Construction Co., 420 Lexington Ave., New York City 1944
PERRY, LYNN, Associate Professor of Civil Engineering, Lafayette College, Easton, Pa. **In military service** 1923
PERRY, RAYMOND J., Lt. Instructor in Chemical Engineering, U. S. Coast Guard Academy, New London, Conn. 1944
PERRYMAN, CONNER C., Associate Professor of Engineering Drawing, Texas Technological College, Lubbock, Texas 1938
PERSON, H. T., Professor and Chairman, Dept. of Civil Engineering, University of Wyoming, Laramie, Wyo. 1932
PESMAN, GERARD J., Assistant Professor of Mechanical Engineering, Montana State College, Bozeman, Mont. 1943
PETERSON, ALDOR C., Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1939
PETERSON, ANDREW I., General Production Engineer, Radio Corp. of America, Camden, N. J. 1933
PETERSON, DONALD I., Supervisor of Communication Training, United Airlines Training Center, 344 Broadmoor Blvd., San Leandro, Calif. 1943
PETERSON, ERNEST F.. Professor of Electrical Engineering, University of Santa Clara, Santa Clara, Calif. 1936
PETERSON, F. G. ERIC, Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. 1929
PETERSON, FRANK T., Mechanical Engineer, Technical Employment, Naval Ordance Laboratory, Navy Yard, Washington, D. C. 1944
PETRIE, GEORGE W., Lt. (jg) Instructor, USNR Midshipmen's School, Notre Dame, Ind. **In military service** 1938
PETRIE, JOHN M., Professor of Chemical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1937
PETTIS, CHARLES R., Water Supply Board, 1980 Suffolk Rd, Columbus 8, Ohio 1943
PETTIT, JOSEPH M., Instructor in Electrical Engineering, University of California, Berkeley, Calif. (Harvard University, Cambridge, Mass.) 1940
PETTY, BENJAMIN H., Professor of Highway Engineering, Purdue University, Lafayette, Ind. **In military service** 1925

PETTYJOHN, ELMORE S., Associate Professor of Chemical Engineering, University of Michigan, Ann Arbor, Mich. **In military service** .. 1939
PEURIFOY, ROBERT L., Director, Division of Engineering, Professor of Civil Engineering, Texas College of Arts and Industries, Kingsville, Texas 1931
PHELEY, DONAL B., Instructor in Physics and Astronomy, Los Angeles City College, Los Angeles, Calif. 1933
PHELPS, CHARLES W., Instructor in Mechanical Engineering, Yale University, New Haven Conn. 1936
PHELPS, GEORGE O., Associate Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1937
PHELPS, GUY M., Professor and Head, Dept. of Drawing, Rensselaer Polytechnic Institute, Troy, N. Y. 1925
PHELPS, J. M., Admissions Counselor, Rose Polytechnic Institute, Terre Haute, Ind. 1941
PHELPS, ROBERT T., Physical Chemist, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1943
PHILBRICK, HERBERT S., Professor of Mechanical Engineering, Emeritus, Northwestern University, Evanston, Ill. 1913
PHILBY, ALFRED J., Assistant Professor of Engineering Drawing, The Ohio State University, Columbus, Ohio 1942
PHILLIPS, ARTHUR, Professor of Metallurgy, Yale University, New Haven, Conn. 1937
PHILLIPS, HENRY B., Professor and Head, Dept. of Mathematics, Massachusetts Institute of Technology, Cambridge, Mass. 1935
PHILLIPS, JOHN B., Associate Professor of Chemical Engineering, McGill University, 4345 Harvard Avenue, Montreal, Canada 1931
PICKELS, GEORGE W., Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1932
PIERCE, CLARENCE A., Professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1925
PIERCE, STANLEY H., Associate in General Engineering Drawing, University of Illinois, Urbana, Ill. 1937
PIERSON, WARNER N., Instructor in Chemical Engineering, University of Detroit, Detroit, Mich. 1942
PIETENPOL, CLARENCE J., Dean of Engineering, Washington and Jefferson College, Washington, Pa. 1942
PIETENPOL, WILLIAM B., Professor and Head, Dept. of Physics, University of Colorado, Boulder, Colo. 1942
PIGAGE, LEO O., Assistant Professor of General Engineering, Purdue University, Lafayette, Ind. 1939
PILCH, MEIR, Professor of Electrical Engineering, University of Idaho, Pocatello, Ida. 1941
PINKERTON, ROBERT M., Professor of Aeronautical Engineering, A. & M. College of Texas, College Station, Texas 1943
PINSKY, JOSEPH, Associate Professor of Mechanical Engineering, Colorado State College, Fort Collins, Colo. 1939
PIRCHIO, PASQUALE M., Professor of Mathematics, University of Notre Dame, Notre Dame, Ind. 1938
PITT, RAYLEIGH ST. C., Lecturer in Mechanical Engineering, University of Western Australia, Nedlands, W. A. 1944
PITTS, ROBERT G., Professor and Head, Dept. of Aeronautical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1938
PIUS, BROTHER LUCIUS, Head, Dept. of Engineering Drawing, St. Mary's College, Winona, Minn. 1944

PLANCK, IVAN A., Professor and Head, Dept. of Mechanical Engineering, Indiana Technical College, Ft. Wayne, Ind. 1943
PLANK, WILLIAM B., Head, Dept. of Mining Engineering and Metallurgy, Lafayette College, Easton, Pa. (*Member of Council, 1938–41.*) 1921
PLANT, L. C., Professor, Retired, of Mathematics, Michigan State College, East Lansing, Mich. 1913
PLETTA, DAN H., Professor of Applied Mechanics, Virginia Polytechnic Institute, Blacksburg, Va. **In military service** 1932
PLOCK, HENRY, Assistant Professor of Drafting, College of the City of New York, New York City 1940
PLOWMAN, ASHLEY S., Professor and Head, Department of Electrical Engineering and Physics, Newcastle Technical College, Newcastle, N.S.W., Australia 1937
PLUMMER, CLAYTON R., Assistant Professor of Engineering Drawing, University of Tennessee, Knoxville, Tenn. Dorm. M-6 Room 142, Oak Ridge, Tenn. 1941
PLUMMER, FRED L., Chief Research Engineer, Hammond Iron Works, Warren, Pa. 1930
POHLE, FREDERICK V., Instructor in Engineering Mechanics, New York University, New York City. **In military service** 1943
POLANER, JEROME L., Assistant Professor of Mechanical Engineering, Newark College of Engineering, Newark, N. J. 1941
POLKINGHORNE, WILFRID C., Associate Professor of Civil Engineering, Michigan College of M. & T., Houghton, Mich. 1939
POLLARD, JAMES J., Associate Professor of Architectural Engineering, Georgia School of Technology, Atlanta, Ga. 1941
POMEROY, GEORGE A., Head, Dept. of Physical Science, San Mateo Junior College, San Mateo, Calif. 1941
POOLE, FRED L., Professor of Electrical Engineering, University of Santa Clara, Santa Clara, Calif. 1929
POOLE, HAROLD M., Assistant Professor of Industrial Engineering, The Ohio State University, Columbus, Ohio. **In military service** 1940
POORMAN, A. P., Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. (*Member of Council, 1932–35.*) 1907
POPE, LATHROP C., Assistant Professor of Civil Engineering, College of the City of New York, New York City 1937
PORSCH, JOHN H., Associate Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1929
PORTER, DAVID B., Professor of Industrial Engineering, New York University, New York City 1923
PORTER, FRANCIS M., Associate Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. 1912
PORTER, GEORGE M., Associate Professor of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1941
PORTER, JAMES M., Assistant Professor of Psychology, Acting Head, Bureau of Measurement and Guidance, Carnegie Institute of Technology, Pittsburgh, Pa. 1943
PORTER, L. MORGAN, Mechanical Engineer, Pratt & Whitney Div., United Aircraft Corp., East Hartford, Conn. 1937
PORTER, R. A., Professor of Physics, Syracuse University, Syracuse, N. Y. 1908
PORTER, ROLAND G., Professor and Head, Department of Electrical Engineering, Northeastern University, Boston, Mass. 1926
PORTILLA, M. MICHAEL, Technical Artist, Tech. Pub., Bell Aircraft Co., Niagara Falls, N. Y. 1943

Posey, Chesley J., Associate Professor of Hydraulics and Structural Engineering, State University of Iowa, Iowa City, Iowa 1931
Potter, Andrey A., Dean, Schools of Engineering, Director Engineering Experiment Station, Purdue University, Lafayette, Ind. (*President, 1924-5; Vice President, 1919-20; Member of Council, 1916-19; 1924-.*) **Thirteenth Recipient, Lamme Medal (1940)** 1908
Potter, James G., Professor of Physics and Administrator of General Engineering, South Dakota School of Mines, Rapid City, S. D. 1935
Potter, James H., Associate in Mechanical Engineering, The Johns Hopkins University, Baltimore, Md. 1941
Potter, James L., Associate Professor, Acting Head, Dept. of Electrical Engineering, Rutgers University, New Brunswick, N. J. 1936
Potter, Orrin W., Assistant Professor of Engineering Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. .. 1925
Potter, Philip J., Assistant Professor of Mechanical Engineering, Bucknell University, Lewisburg, Pa. 1942
Powell, Albert P., Assistant Professor of Electrical Engineering, The Pennsylvania State College, State College, Pa. 1926
Powell, Ralph W., Associate Professor of Mechanics, The Ohio State University, Columbus, Ohio 1922
Power, Harry H., Professor of Petroleum Engineering, University of Texas, Austin, Texas 1938
Power, Roy B., Lecturer, Harvard University, Cambridge, Mass. 1944
Powers, A. Raymond, Professor of Electrical Engineering, Clarkson College of Technology, Potsdam, N. Y. 1941
Powers, Louis J., Associate Professor of Mechanical Engineering, Texas Technological College, Lubbock, Texas 1944
Praeger, Emil, Professor and Head, Dept. of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1939
Prageman, Irving H., Professor of Mechanical Engineering, University of Maine, Orono, Maine 1923
Pratt, Charles, Secretary, Board of Trustees, Pratt Institute, Brooklyn, N. Y. 1929
Pratt, Grover M., Assistant Professor of Drawing and Design, Michigan State College, East Lansing, Mich. 1935
Preisman, Albert, Director, Engineering Texts, Capitol Radio Engineering Institute, Washington, D. C. 1943
Prentice, Donald B., President, Rose Polytechnic Institute, Terre Haute, Ind. (*President, 1940-41; Vice President, 1939-40; Member of Council, 1927-30, 1939-.*) 1912
Prentice, Thomas H., Assistant Professor of Civil Engineering, College of the City of New York, New York City 1936
Preston, Howard K., Professor and Head, Dept. of Mechanics, University of Delaware, Newark, Del. 1942
Prewett, Cheryl H., Instructor in Engineering, University of Omaha, Omaha, Nebr. 1943
Prian, Vasily D., Acting Head, Dept. of Mechanical Engineering, Fenn College, Cleveland, Ohio 1936
Price, F. Earl, Professor of Agricultural Engineering, Oregon State College, Corvallis, Ore. 1944
Price, Harold W., Professor of Electrical Engineering, University of Toronto, Toronto, Ont., Canada 1924
Price, John R., Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1926

PRICE, LEONARD C., Professor of Mechanical Engineering, Michigan State College, East Lansing, Mich. 1931
PRICE, M. LAWRENCE, Assistant Professor of Machine Design, Worcester Polytechnic Institute, Worcester, Mass. 1944
PRICE, REGINALD C., Assistant Professor of Engineering, New York University, New York City 1944
PRICE, ROBERT, Instructor in English, The Ohio State University, Columbus, Ohio 1942
PRICE, SHERWOOD R., Instructor in Language, Michigan College of M. & T., Houghton, Mich. 1943
PRIEN, CHARLES H., Assistant Professor of Chemical Engineering, University of Colorado, Boulder, Colo. 1941
PRIESTER, GAYLE B., Assistant Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio 1941
PRIESTER, GEORGE C., Professor and Head, Dept. of Mathematics and Mechanics, University of Minnesota, Minneapolis, Minn. 1920
PRIOR, JOHN A., Assistant Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. 1923
PRIOR, JOHN C., Professor of Civil and Sanitary Engineering, The Ohio State University, Columbus, Ohio 1926
PRIOR, THOBURN W., Personnel Dept., Goodyear Tire and Rubber Co., Akron, Ohio 1937
PROCTOR, WILLIAM J., Associate Professor of Economic and Social Science, Georgia School of Technology, Atlanta, Ga. 1944
PROGNER, FRED W., Instructor in Mechanics, New York University, New York City 1943
PROSSER, EDWARD T., Associate Professor of Physics, Georgia School of Technology, Atlanta, Ga. 1944
PUCHSTEIN, ALBERT F., Electrical Engineer, The Jeffry Mfg. Co., Columbus, Ohio 1928
PUCKETT, HARVEY R., Instructor in Mechanics, University of Wisconsin, Madison, Wis. 1943
PUFFER, LOUIS B., Professor of Civil Engineering, University of Vermont, Burlington, Vt. 1922
PUGH, EMERSON M., Associate Professor of Physics, Carnegie Institute of Technology, Pittsburgh, Pa. 1938
PUGSLEY, ALBERT L., Professor of Structural Engineering, Assistant Director, Engineering Experiment Station, Kansas State College, Manhattan, Kans. 1943
PULLEN, M. W., Associate in Electrical Engineering, Johns Hopkins University, Baltimore, Md. 1909
PULVER, HARRY E., Professor of Civil and Structural Engineering, University of Wisconsin, Madison, Wis. 1929
PUMPHREY, FRED H., Professor and Head, Dept. of Electrical Engineering, Rutgers University, New Brunswick, N. J. 1928
PURDIE, K. S., Associate Professor of Mathematics, Virginia Military Institute, Lexington, Va. **In military service** 1927
PURNELL, LEE J., Associate Professor of Electrical Engineering, Howard University, Washington, D. C. 1943
PUTNAM, GERALD, Assistant Professor of Graphics, Massachusetts Institute of Technology, Cambridge, Mass. 1944
PUTNAM, RUSSELL C., Associate Professor of Illumination and Engineering Administration, Case School of Applied Science, Cleveland, Ohio 1927
PYLER, OTIS G., Tools and Methods Engineer, Republic Aviation Corp., 156 Hampton Blvd., Massapequa, L. I., N. Y. 1943

QUAID, LLOYD J., Instructor in Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. 1931
QUARLES, LAWRENCE R., Associate Professor of Electrical Engineering, University of Virginia, University, Va. 1938
QUATTLEBAUM, ALEXANDER M., Assistant Professor of Civil Engineering, Clemson College, Clemson, S. C. **In military service** 1941
QUENEAU, BERNARD R., Assistant Professor of Metallurgy, Columbia University, New York City 1940
QUERY, LEO H., Associate Professor of Industrial Engineering, University of Rochester, Rochester, N. Y. 1938
QUIER, KENNETH E., Associate Professor of Mechanical Technology, Pratt Institute, Brooklyn, N. Y. 1929
QUINN, BAYARD E., Instructor in Machine Design, Cornell University, Ithaca, N. Y. 1942
QUINN, GERALD S., Instructor in Engineering Drawing, Case School of Applied Science, Cleveland, Ohio 1939
RABER, B. F., Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1915
RACKWAY, JOHN S., Head, Dept. of Drawing, Lawrence Institute of Technology, Highland Park, Mich. 1943
RADASCH, ARTHUR H., Professor and Head, Dept. of Chemical Engineering, Cooper Union, New York City 1939
RADER, LLOYD F., Professor of Civil Engineering, in charge, Highway Engineering and City Planning, University of Wisconsin, Madison, Wis. **In military service** 1925
RADFORD, STANLEY S., Assistant Professor of Drawing and Design, Michigan State College, East Lansing, Mich. 1937
RADFORD, WILLIAM H., Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943
RAEDER, WARREN, Professor and Head, Dept. of Civil Engineering, University of Colorado, Boulder, Colo. 1938
RAGATZ, ROLAND A., Professor and Chairman, Dept. of Chemical Engineering, University of Wisconsin, Madison, Wis. 1927
RAHM, LOUIS F., Associate Professor of Mechanical Engineering, Princeton University, Princeton, N. J. 1935
RAINEY, GLENN W., Associate Professor of English, Georgia School of Technology, Atlanta, Ga. 1944
RAMBERG, EIVIND G. F., Associate Engineer, Stress Dept., Otis Elevator Co., New York City 1939
RAMLER, WARREN J., 5509 Radio Road, Villa Gardens, Fountain City, Tenn. 1943
RANDALL, MERLE, Director of Research, Stuart Oxygen Co., 2295 San Pablo, Berkeley, Calif. 1940
RANDOLPH, EDGAR E., Professor and Head, Dept. of Chemical Engineering, North Carolina State College, Raleigh, N. C. 1932
RANSDELL, CLIFFORD H., Assistant Professor of Engineering Drawing, A. & M. College of Texas, College Station, Texas 1942
RAPPOLT, FRANK A., Assistant Professor of Drafting, College of the City of New York, New York City 1940
RASCHE, WILLIAM H., Professor of Mechanism, Virginia Polytechnic Institute, Blacksburg, Va. 1931
RATH, EDWIN R., Vice President, Power Transmission Council, 41 Park Row, New York 7, N. Y. 1919
RATHBUN, JOHN C., Professor of Civil Engineering, College of the City of New York, New York City 1925

RAUDEBAUGH, ROBERT J., Professor of Metallurgical Engineering, University of Rochester, Rochester, N. Y. 1944
RAUDENBUSH, CHARLES, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio 1943
RAVENSCROFT, HENRY A., Instructor in Physics, Santa Rosa Junior College, Santa Rosa, Calif. 1943
RAW, RUTH, Assistant Professor of English, University of Akron, Akron, Ohio 1935
RAY, B. M., 2614 Stonewall St., Shreveport, La. 1942
RAYNER, WM. H., Associate Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1913
REA, GEORGE P., President, Drexel Institute of Technology, Philadelphia, Pa. 1943
READ, THOMAS T., Vinton Professor of Mining Engineering, Columbia University, New York City 1933
REARDON, LESLIE J., Assistant Professor of Applied Mechanics, Case School of Applied Science, Cleveland, Ohio 1944
REASER, WILLIAM E., Associate Professor of Mechanical Engineering, Lafayette College, Easton, Pa. 1942
REBER, LOUIS E., 242 Lakeland Drive, W. Palm Beach, Fla. (*Member of Council, 1901–7.*) 1893
RECORD, FRANK A., Research Associate, Harvard University, Cambridge, Mass. 1940
REED, FREDERICK J., Assistant Professor of Mechanical Engineering, Duke University, Box 263, Durham, N. C. 1936
REED, HENRY R., Professor of Electrical Engineering, State University of Iowa, Iowa City, Iowa 1935
REED, JOHN C., Professor and Head, Dept. of Mechanical Engineering, Bucknell University, Lewisburg, Pa. 1929
REED, K. W., Consulting Engineer, 4614 Prospect Ave., Cleveland 3, Ohio 191[illegible]
REED, MYRIL B., Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1938
REED, PERCY L., Professor and Head, Dept. of Civil Engineering, University of Florida, Gainesville, Fla. 1914
REEKS, MARK R., Assistant Professor of Mathematics, Stevens Institute of Technology, Hoboken, N. J. 1940
REEL, FRED R., Assistant Professor of Mathematics, Illinois Institute of Technology, Chicago, Ill. 1939
REESE, RAYMOND C., Lecturer in Structural Engineering, University of Toledo, Toledo, Ohio 1933
REICH, HERBERT J., Special Research Assoc., Radio Research Lab., Cambridge 38, Mass. 1934
REID, CHARLES T., Assistant to Vice President, Douglas Aircraft Co., Inc., 1102 Pacific St., Santa Monica, Calif. 1938
REID, ERNEST A., Associate Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1938
REID, GEORGE W., Assistant Professor of Civil Engineering, University of Florida, Gainesville, Fla. 1943
REINSCH, BERNHARD P., Professor and Head, Department of Mathematics, Florida Southern College, Lakeland, Fla. 1931
REINTJES, J. FRANK, Visiting Assistant Professor of Electrical Communications, Massachusetts Institute of Technology, Cambridge, Mass. 1937
RENNER, WILLIAM E., Head, Dept. of Administrative Engineering, Syracuse University, Syracuse, N. Y. **In military service** 1940

RENWICK, DONALD J., Assistant Professor of Mechanical Engineering, University of North Dakota, Grand Forks, N. D. 1941
REPSCHA, ALBERT H., Associate Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1933
REW, IRWIN, Trustee of Northwestern University, 217 Dempster St., Evanston, Ill. 1913
REYHNER, THEODORE O., Engineer P-3, Div. of Timber Mechanics, Forest Products Lab., Madison, Wis. 1943
REYNOLDS, KENNETH C., Professor and Head, Dept. of Civil Engineering, Cooper Union, New York, N. Y. 1934
RHODES, FRED H., Assistant Professor of Civil Engineering, University of Washington, Seattle, Wash. **In military service** 1938
RHODES, FRED H., Director, School of Chemical Engineering, Herbert Fisk Johnson Professor of Industrial Chemistry, Cornell University, Ithaca, N. Y. 1941
RHODES, LELAND S., Associate Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. 1925
RHODES, SAM R., Professor and Head, Division of Electrical Engineering, Clemson Agricultural College, Clemson College, S. C. 1927
RHODES, THOMAS J., Research Engineer, U. S. Rubber Co., Passaic, N. J. 1943
RHODES, WALTER K., Professor of Electrical Engineering, Emeritus, Bucknell University, Lewisburg, Pa. 1925
RICE, HAROLD S., Instructor in Mathematics, Wentworth Institute, Boston, Mass. 1943
RICE, HARRIS, Professor of Mathematics, Worcester Polytechnic Institute, Worcester, Mass. 1919
RICE, PAUL P., Assistant Professor of Civil Engineering, Lafayette College, Easton, Pa. 1932
RICE, PHILIP X., Associate Professor of Electrical Engineering, The Pennsylvania State College, State College, Pa. 1931
RICE, ROBERT B., Professor and Head, Dept. of Mechanical Engineering, North Carolina State College, Raleigh, N. C. 1931
RICH, NATHAN H., Instructor in Mechanical Engineering, Thayer School of Engineering, Hanover, N. H. 1944
RICH, RONALD E., Professor and Head, Dept. of Chemical Engineering, University of Notre Dame, Notre Dame, Ind. 1944
RICHARDS, HENRY E., Associate Professor of Electrical Engineering, Northeastern University, Boston, Mass. 1935
RICHARDS, VICTOR F., Supervisor, Industrial Training, Consolidated-Vultee Aircraft Co., San Diego, Calif. 1943
RICHARDSON, DONALD E., Physicist, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. 1929
RICHARDSON, LOUIS A., Associate Professor of Architectural Engineering, The Pennsylvania State College, State College, Pa. 1938
RICHMOND, ADDISON E., Assistant Professor of Civil Engineering, Howard University, Washington, D. C. 1931
RICHTMANN, WILLIAM M., Professor and Head, Dept. of Mechanical Engineering, Colorado School of Mines, Golden, Colo. 1938
RICKER, CLAIRE W., Professor and Head, Dept. of Electrical Engineering, Tulane University, New Orleans, La. 1921
RIDDLE, KENNETH W., Assistant Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937
RIDINGS, PAUL O., Director of News Bureau, Illinois Institute of Technology, Chicago, Ill. 1942

RIEBETH, THEODORE J., Assistant Professor of Mechanical Engineering, Marquette University, Milwaukee, Wis. 1943
RIEDERER, FRANK W., Lt. (jg), A-V(S). USNR, 2035 E. 72nd Place, Chicago, Ill. In military service .. • 1943
RIEDESEL, GERHARD A., Assistant Professor and Acting Head, Dept. of Civil Engineering, University of Idaho, Moscow, Idaho 1942
RIETZKE, EUGENE H., President, Capitol Radio Engineering Institute, 3224 16th St., N.W., Washington, D. C. 1943
RIFFENBERG, HARRY B., Associate Professor of Chemistry, Virginia Polytechnic Institute, Blacksburg, Va. 1937
RIKER, CHARLES R., Supervisor of Extension Training, Westinghouse E. & M. Co., East Pittsburgh, 101 Woodhaven Drive, Pittsburgh, Pa. .. 1939
RINEHART, H. WADE, Manager, Personnel Dept., E. I. du Pont de Nemours & Co., Wilmington, Del. 1941
RISING, JUSTUS, Professor of Engineering Drawing, Purdue University, Lafayette, Ind. 1926
RISK, GEORGE, President, Electronic Radio-Television Institute, 1336 No. Sadale Creek Road, Omaha, Neb. 1943
RISTEEN, HORACE W., Associate Professor of Mechanical Engineering, Michigan College of M. & T., Houghton, Mich. In military service 1935
RITTENHOUSE, L. H., Professor of Electrical Engineering, Emeritus, Haverford College, Haverford, Pa. 1906
RITTER, IRVING F., Assistant Professor of Mathematics, New York University, New York City 1938
RIX, CLIFFORD N., Associate Professor of Mechanical Engineering, Michigan State College, East Lansing, Mich. 1941
RIZZI, ANTHONY V., Instructor in Civil Engineering, College of the City of New York, New York City. In military service 1940
ROARK, RAYMOND J., Professor of Mechanics, University of Wisconsin, Madison, Wis. 1919
ROBBINS, ARTHUR G., Professor of Topographical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1894
ROBBINS, JAMES M., Associate Professor of Civil Engineering, Acting Head of Dept., Newark College of Engineering, Newark, N. J. 1937
ROBBINS, PAUL H., Director, Civilian Training, War Dept., N. Y. Port of Embarkation, New York, N. Y. 1939
ROBERT, JAMES M., Dean, College of Engineering, Tulane University, New Orleans, La. 1922
ROBERT, JULES H., Professor of Applied Mechanics, Kansas State College, Manhattan, Kans. 1926
ROBERT, RENE A., Associate Professor of Physics, Ecole Polytechnique, Montreal, Canada, ... 1942
ROBERTS, CHARLES P., Associate Professor of Mechanical Engineering, The Ohio State University, Columbus, Ohio 1926
ROBERTS, EMERSON B., Assistant Vice President, Westinghouse E. & M. Co., 306 4th Avenue, Pittsburgh, Pa. 1919
ROBERTS, ERSKINE G., Assistant Professor of Mechanic Arts, Lincoln University, Jefferson City, Mo. 1941
ROBERTS, MILNOR, Dean, College of Mines, University of Washington, Seattle, Wash. 1910
ROBERTSON, BURTON J., Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1922
ROBERTSON, JAMES E., Assistant Professor of Drawing and Design, Michigan State College, East Lansing, Mich. 1938

ROBINSON, DOUGLAS I., Personnel Manager, Brush Plant, Sperry Gyroscope Co., Inc., Brooklyn, N. Y. 1941

ROBINSON, MAX B., Acting Dean, Fenn College, Cleveland, Ohio 1915

ROBINSON, OTTO L., Associate Professor of Fire Protection Engineering, Illinois Institute of Technology, Chicago, Ill. 1941

ROBINSON, ROBERT H., Associate Professor of Mathematics, Ecole Polytechnique, Montreal, Canada 1942

ROBINSON, WALTER, Instructor in Mechanical Engineering, The Ohio State University, Columbus, Ohio 1943

ROBSON, FRED B., Instructor in Industrial Engineering and Drawing, Texas Technological College, Lubbock, Texas 1942

RODE, NORMAN F., Professor of Electrical Engineering, Texas A. & M. College, College Station, Texas 1936

RODES, HAROLD P., Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. 1944

RODMAN, GEORGE E., Instructor, Industrial Relations Dept., Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill. 1944

RODMAN, WALTER S., Professor of Electrical Engineering, Dean, University of Virginia, University, Va. (*Vice President, 1926–7; Member of Council, 1919–22.*) 1915

ROE, HARRY B., Professor of Agricultural Engineering, University of Minnesota, University Farm, St. Paul, Minn. 1925

ROEHRIG, GEORGE F., Associate Professor of Civil Engineering, Lafayette College, Easton, Pa. 1926

ROEMMELE, HERBERT F., Associate Professor of Mechanical Engineering, Cooper Union, New York City 1927

ROESCH, DANIEL, Professor of Automotive Engineering, Illinois Institute of Technology, Chicago, Ill. 1939

ROEVER, FREDERICK H., Supt. of Instruction, Parks Air College, East St. Louis, Mo. 1943

ROEVER, WILLIAM H., Professor and Head, Dept. of Mathematics and Astronomy, Washington University, St. Louis, Mo. 1944

ROGERS, FRANKLYN C., Assistant Professor of Civil Engineering, Rutgers University, New Brunswick, N. J. 1944

ROGERS, FRED S., Professor of Machine Design, Cornell University, Ithaca, N. Y. 1936

ROGERS, H. BARRETT, Professor of Industrial Management, Northwestern University, Evanston, Ill. 1940

ROGERS, H. S., President, Brooklyn Polytechnic Institute, Brooklyn, N. Y. (*President, 1944–45; Vice President, 1932–33; Member of Council, 1928–31, 1941–.*) 1922

ROGERS, PAUL, Structural Engineer, Hiram Walker & Sons, Inc., Peoria, Ill. 1943

ROHLICH, GERARD A., Senior Civil Engineer, Office, Chief of Engineers, War Dept., Washington, D. C. 1938

ROHR, ERWIN K., Assistant Design Engineer, Generator Dept., General Electric Co., Lynn, Mass. 1940

ROHRBACH, GEORGE E., Associate Professor of Mechanical Engineering, University of Notre Dame, Notre Dame, Ind. 1938

ROLLINS, EDWIN B., Professor of Electrical Engineering, Emeritus, Tufts College, Medford, Mass. 1912

ROMANOWITZ, HARRY A., Associate Professor of Electrical Engineering, University of Kentucky, Lexington, Ky. 1943

RONAN, WILBERT C., Professor of Architecture, The Ohio State University, Columbus, Ohio 1943

ROOK, CHARLES W., Assistant Professor of Electrical Engineering, University of North Dakota, Grand Forks, N. D. 1944
ROOP, FRANK S., Assistant Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1936
ROOS, PHILIP K., Instructor in Civil Engineering, The Pennsylvania State College, Du Bois Undergraduate Center, Du Bois, Pa. **In military service** .. 1939
ROOT, RALPH E., Professor of Mathematics and Mechanics, Postgraduate School, U. S. Naval Academy, Annapolis, Md. 1914
ROSE, FRANK W., Head, Science Dept., Taft Junior College, Taft, Calif. 1933
ROSE, FRANKLIN O., Associate Professor of Civil Engineering, Brown University, Providence, R. I. 1928
ROSE, LISLE A., Professor and Head, Dept. of Languages, Michigan College of M. & T., Houghton, Mich. 1940
ROSE, LOUIS H., Associate Professor and Head, Dept. of Electrical Engineering, University of Dayton, Dayton, Ohio 1937
ROSE, WILLIAM A., Associate Professor of Structural Engineering, New York University, New York City 1938
ROSELLA, EDWARD G., Instructor in Architectural Engineering, University of Detroit, Detroit, Mich. 1942
ROSENBACH, J. B., Professor of Mathematics, Carnegie Institute of Technology, Pittsburgh, Pa. 1939
ROSS, FREDERICK W., Professor and Head, Dept. Geography and Geology, Alfred University, Alfred, N. Y. 1941
ROSS, JOHN A., President, Clarkson College of Technology, Potsdam, N. Y. 1926
ROSSELOT, GERALD A., Director, Engineering Experiment Station, Georgia School of Technology, Atlanta, Ga. 1943
ROSSI, BONIFACE E., Director, Welding Division, The Delehanty Institute, 40 35 24th St., Long Island City, N. Y. 1942
ROTH, SIDNEY G., Instructor in Mathematics, Cooper Union, New York City 1942
ROUDEBUSH, R. E., Associate Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1932
ROUSH, MYRTLE B., Librarian, Arkansas Polytechnic College, Russellville, Ark. 1942
ROWE, CHARLES E., Professor of Drawing, Assistant Dean, University of Texas, Austin, Texas 1935
ROWLEY, F. B., Professor and Head, Dept. of Mechanical Engineering; Director, Experimental Engineering Laboratories, University of Minnesota, Minneapolis, Minn. 1910
ROYER, WESLEY C., Instructor in Engineering Drawing, Virginia Polytechnic Institute, Blacksburg, Va. **In military service** .. 1943
ROYS, FRANCIS W., Dean of Engineering, Professor and Head, Dept. of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1925
RUBENKOENIG, HARRY, Professor of Railway Mechanical Engineering, Purdue University, Lafayette, Ind. 1920
RUBEY, HARRY, Chairman, Civil Engineering Dept., University of Missouri, Columbia, Mo. (*Member of Council, 1932–35.*) 1917
RUDENBERG, REINHOLD, Professor of Electrical Engineering, Harvard University, Cambridge, Mass. 1944
RUGGLES, EDWARD W., Director, College Extension Division, North Carolina State College, Raleigh, N. C. 1941

RUHL, ROBERT C., Head, Dept. of Civil Engineering, Indiana Technical College, Ft. Wayne, Ind. 1943
RULE, JOHN T., Associate Professor of Graphics, Massachusetts Institute of Technology, Cambridge, Mass. 1940
RUNGE, LULU L., Assistant Professor of Mathematics, University of Nebraska, Lincoln, Nebr. 1940
RUSH, HARRY S., Professor of Electrical Engineering, Assistant Dean, North Dakota Agricultural College, Fargo, N. D. 1919
RUSH, PHILIP E., Assistant Professor of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1939
RUSHTON, J. H., Professor of Chemical Engineering, University of Virginia, University, Va. 1935
RUSS, JOHN M., Associate Professor of Engineering Drawing, State University of Iowa, Iowa City, Iowa 1924
RUSSELL, CHESTER, Electrical Engineer, Chandeysson Electric Co., St. Louis, Mo. 1930
RUSSELL, DONALD M., Instructor in Mechanical Engineering, Rice Institute, Houston, Texas 1942
RUSSELL, DORIS A., Instructor in English, Northeastern University, Boston, Mass. 1944
RUSSELL, FRANK A., Professor of Engineering Drawing, University of Kansas, Lawrence, Kans. 1922
RUSSELL, FREDERICK A., Engineer, Dept. of War Research, Columbia University, New York 27, N. Y. 1943
RUSSELL, JOHN J., Head, Dept. of Chemistry, Franklin Technical Institute, Boston, Mass. 1940
RUTEN, WILLIAM H., Assistant Professor of Practical Mechanics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1938
RUTH, BURRELL F., Professor of Chemical Engineering, Iowa State College, Ames, Iowa 1936
RUTLEDGE, PHILIP C., Professor of Civil Engineering, Northwestern University, Evanston, Ill. 1937
RUTTER, M. L., Lieut., C. E. C., U. S. N., Box 311, Parris Island, S. C. .. 1939
RYAN, DAVID G., Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1941
RYAN, JAMES J., Associate Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1943
RYCKMAN, SEYMOUR J., Assistant Professor of Civil Engineering, University of Maine, Orono, Me. **In military service** 1942
RYDER, JOHN D., Professor of Electrical Engineering, Iowa State College, Ames, Iowa 1941
RYON, LEWIS B., JR., Professor of Civil Engineering, Rice Institute, Houston, Texas 1925
SABBAGH, ELIAS M., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1930
SACKETT, R. L., Dean Emeritus, School of Engineering, Pennsylvania State College, 303 Lexington Ave., New York City. (*Member of Council, 1897–1900; 1927–; President, 1927–28.*) **Eleventh Recipient, Lamme Medal (1938)** 1923
SADLER, WALTER C., Associate Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. **In military service** 1940
SAGEN, GEORGE O., Physics Instructor, Bakersfield Junior College, Bakersfield, Calif. 1934
SAGER, EDWIN H., Instructor in Mechanical Engineering, Washington University, St. Louis, Mo. **In military service** 1939

SAHAG, LEON M., Professor of Machine Design and Drawing, Alabama Polytechnic Institute, Auburn, Ala. 1927
SAIDLA, LEO E. A., Associate Professor of English, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1944
SALMA, EMANUEL A., Instructor in Mechanical Engineering, Cooper Union, New York, N. Y. 1930
SALTZER, BERTRAM H., Assistant Administrator, Wright Aero. Corp., Paterson, N. J. 1936
SAMPSON, MARTIN W., Instructor in Administrative Engineering, Cornell University, Ithaca, N. Y. 1941
SANDERS, THOMAS K., Assistant Professor, Engineering Experiment Station, Purdue University, Lafayette, Ind. 1941
SANDERS, WILLIAM B., Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. 1922
SANDOVOL VALLARTA, MANUEL, Puente de Alvarada 71, Mexico, D. F., Mexico 1943
SANDORF, IRVING J., Associate Professor of Electrical Engineering, U. S. Naval Academy, Annapolis, Md. 1938
SANDSTEDT, CARL E., Professor and Actirg Head, Dept. of Civil Engineering, A. & M. College of Texas, College Station, Texas 1938
SANTRY, ISRAEL W., Assistant Professor of Civil Engineering, Southern Methodist University, Dallas, Texas 1942
SARBACHER, ROBERT I., Assistant Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. **In military service** 1941
SARTAIN, CARL C., Instructor in Physics, University of Alabama, University, Ala. **In military service** 1940
SATULLO, ANTHONY R., Instructor in Electrical Engineering, University of Detroit, Detroit, Mich. 1941
SAVANT, D. P., Professor and Head, Dept. of Electrical Engineering, Dean of Engineering, Georgia School of Technology, Atlanta, Ga. (*Member of Council, 1940–43.*) 1917
SAVILLE, THORNDIKE, Dean, College of Engineering, New York University, New York City. (*Member of Council, 1943–46.*) 1915
SAWYER, CHARLES N., Colonel, Signal Corps, Halosbird Sig. Depot, Baltimore 19, Md. 1943
SAWYER, RALPH A., Assistant Engineer, Stromberg Carlson Mfg. Co., Rochester, N. Y. 1941
SAYLOR, WILLIAM R., Instructor in Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943
SAYRE, MORTIMER F., Professor of Applied Mechanics, Union College, Schenectady, N. Y. 1917
SCAMMAN, WILLIAM F., Associate Professor of English, University of Maine, Orono, Me. 1927
SCHAEFER, VERNON G., Coordinator, Supervising Training, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1942
SCHAFFNER, CHARLES E., Instructor in Civil Engineering, Cooper Union, New York City 1943
SCHAFFNER, ROBERT M., Chemical Engineer, Research Staff, Standard Oil Co. 1938
SCHART, WILLIAM J., c/o General Delivery, Dayton, Ohio 1944
SCHEALER, SAMUEL R., Professor and Head, Dept. of Electrical Engineering, Vanderbilt University, Nashville, Tenn. 1911
SCHEIFLEY, CLAUDE K., Assistant Professor of Modern Languages and History, Worcester Polytechnic Institute, Worcester, Mass. 1939

SCHEINMAN, JAY, Assistant Professor of Engineering, University of Redlands, Redlands, Calif. 1943

SCHELL, ERWIN H., Professor in Charge of Business and Engineering Administration, Massachusetts Institute of Technology, Cambridge, Mass. 1940

SCHLESINGER, GEORG, Director of Engineering, Institution of Production Engineers, London, England 1944

SCHILLING, E. W., Dean, Div. of Engineering, Montana State College, Bozeman, Mont. 1935

SCHIMMEL, FRED A., Chairman, Dept. of Engineering, Drew University, 153 Park Ave., Madison, N. J. 1944

SCHLEGEL, EDWARD J., Assistant Professor of Mechanical Drawing, Bradley Polytechnic Institute, Peoria, Ill. 1942

SCHMELZER, RICHARD W., Assistant Professor of English, Rensselaer Polytechnic Institute, Troy, N. Y. 1943

SCHMIDT, MILTON O., Instructor in Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. **Military service** 1943

SCHMIDT, HARRY P., Box 1791, Southern Arizona School, Tucson, Ariz. .. 1930

SCHNEIDER, THEODORE A., Research Engineer, Newark College of Engineering, Newark, N. J. 1943

SCHNEIDEWIND, RICHARD, Associate Professor of Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. 1940

SCHOCK, EDSON I., Assistant Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. 1937

SCHODER, ERNEST W., Professor of Experimental Hydraulics, Cornell University, Ithaca, N. Y. 1934

SCHOENBORN, EDWARD M., Associate Professor of Chemical Engineering, University of Delaware, Newark, Del. 1935

SCHOLER, CHARLES H., Professor of Applied Mechanics, Kansas State College, Manhattan, Kans. 1925

SCHOMMER, JOHN T., Professor of Industrial Chemistry, Director of Placement, Trustee, Illinois Institute of Technology, Chicago, Ill. .. 1928

SCHOOLER, DURWARD R., Assistant Professor of Drawing, Missouri School of Mines, Rolla, Mo. 1944

SCHOONOVER, BONNIE-BLANCHE, Librarian, Worcester Polytechnic Institute, Worcester, Mass. 1943

SCHOONOVER, REX H., Professor and Head, Dept. of Engineering Mechanics, Wayne University, Detroit, Mich. 1937

SCHRADER, HERMAN J., Research Associate Professor of T. & A. M., University of Illinois, Urbana, Ill. 1925

SCHRAMM, E FRANK, Chairman, Dept. of Geology, University of Nebraska, Lincoln, Nebr. 1940

SCHREIBER, NORMAN B., Professional Lecturer in Industrial Management, Illinois Institute of Technology, Chicago, Ill. 1943

SCHRENK, WALTER T., Professor and Head, Dept. of Chemical Engineering and Chemistry, Missouri School of Mines, Rolla, Mo. 1939

SCHUBMEHL, RAYMOND J., Professor of Civil Engineering, Acting Dean, University of Notre Dame, Notre Dame, Ind. 1938

SCHUCK, ROBERT F., Assistant Professor of Drawing and Descriptive Geometry, University of Minnesota, Minneapolis, Minn. 1925

SCHUHMANN, REINHARDT, Assistant Professor of Mineral Dressing, Massachusetts Institute of Technology, Cambridge, Mass. 1942

SCHULTE, WILLIAM C., Chief Metallurgist, Curtis-Wright Corp., Caldwell, N. J. 1938

SCHULTZ, F. V., Instructor in Electrical Engineering, Michigan State College, East Lansing, Mich. 1939
SCHULTZ, ELMER H., Assistant Professor of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 1938
SCHUMANN, CHARLES H., JR., Professor of Engineering Drawing and Descriptive Geometry, Franklin and Marshall College, Lancaster, Pa. 1925
SCHUMANN, FRED., Associate Professor of Electrical Engineering, Vanderbilt University, Nashville, Tenn. 1944
SCHUREMAN, LESLIE R., Field Representative, ESMWT, U. S. Office of Education, Washington, D. C. 1943
SCHUTT, WILLIAM H., President, Detroit Time Study School, Inc., 1556 Infantry Ave., Detroit, Mich. 1943
SCHUTZ, HARALD, Senior Research Engineer, Ratheon Mfg. Co., Waltham, Mass. 1942
SCHUTZ, PHILIP W., Assistant Professor of Chemical Engineering, Columbia University, New York City 1939
SCHUYLER, WILLIAM H., Assistant Professor of Chemical Engineering, Bucknell University, Lewisburg, Pa. 1943
SCHWANTES, ARTHUR J., Professor and Chief, Division of Agricultural Engineering, University of Minnesota, St. Paul, Minn. 1926
SCHWARTZ, FRANK L., Associate Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1930
SCHWARZLOSE, PAUL F., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. 1942
SCHWIEGER, ALBERT J., Professor and Head, Dept. of Economics, Government and Business, Worcester Polytechnic Institute, Worcester, Mass. **In military service** 1938
SCIPIO, L. A.,.. 1910
SCOFIELD, J. HARRY, Associate Professor of Mechanical Engineering, Colorado State College, Ft. Collins, Colo. 1938
SCOFIELD, W. FLEMING, Associate Professor of Civil Engineering, Tulane University, New Orleans, La. 1940
SCOTT, ERMAN O., Associate Professor of Civil Engineering and Engineering Mechanics, University of Toledo, Toledo, Ohio 1941
SCOTT, GLENN A., Assistant Professor of Aeronautics, Alabama Polytechnic Institute, Auburn, Ala. 1943
SCOTT, JOHN E., Associate Physicist, University of California, San Diego, Calif. 1943
SEABURY, GEORGE T., Secretary, American Society of Civil Engineers, 33 West 39th Street, New York City. (*Member of Council, 1940–43.*) 1926
SEAGRAVES, WAYLAND P., Assistant Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1937
SEAL, PHILIP M., Instructor in Electrical Engineering, Purdue University Lafayette, Ind. 1943
SEARLE, FREDERICK E., Superintendent, Ford Industrial Schools, Ford Motor Co., Dearborn, Mich. 1942
SEARLES, CHARLES L., Public and Civic Relations Dept., Western Electric Company, Kearny, N. J. 1930
SEATON, R. A., Dean, Division of Engineering, Director, Engineering Experiment Station, Kansas State College, Manhattan, Kans. (*President, 1932–33; Vice President, 1930–31; Member of Council, 1926–29; 1930–.*) 1912
SEAVER, HENRY L., Professor of History, Massachusetts Institute of Technology, Cambridge, Mass. 1908

Seaver, William N., *Librarian, Institute Library, Massachusetts Institute of Technology, Cambridge, Mass.* 1941

Sechrist, Gilbert H., Professor and Chairman, Dept. of Electrical Engineering, University of Wyoming, Laramie, Wyo. 1927

Sedgewick, Charles H. W., Associate Professor of Mathematics, University of Connecticut, Storrs, Conn. 1944

Seegrist, Walter H., Associate Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. 1934

Seeley, Lauren E., Associate Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1935

Seeley, Walter J., Professor and Chairman, Dept. of Electrical Engineering, Duke University, Durham, N. C. 1927

Seely, F. B., Professor and Head, Dept. of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. (*Member of Council, 1937–40*) 1913

Seely, J. Frank, Assistant Professor of Chemical Engineering, North Carolina State College, Raleigh, N. C. 1941

Seely, Samuel, Instructor in Electrical Engineering, College of the City of New York, New York City 1942

Seibert, Charles B., Associate Professor of Electrical Engineering, West Virginia University, Morgantown, W. Va. 1942

Seidl, Julius C. G., Director of Personnel, Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, 6, N. Y. 1935

Seitz, Frederick, Professor and Head, Dept. of Physics, Carnegie Institute of Technology, Pittsburgh, Pa. 1943

Sellner, E. P., Graduate Student, Harvard University, Cambridge, Mass. 1944

Selvidge, Harner, Associate Professor of Electrical Engineering, Kansas State College, Manhattan, Kansas 1938

Sergev, Serguis I., Associate Professor of Civil Engineering, University of Washington, Seattle, Wash. 1943

Sermon, Thomas C., Associate Professor of Physics, Michigan College of M. & T., Houghton, Mich. 1944

Serviss, Frederick L., Professor of Geology, Purdue University, Lafayette, Ind. 1929

Sessums, Roy T., Dean, School of Engineering, Louisiana Polytechnic Institute, Ruston, La. **In military service** 1939

Setchell, John E., Assistant Professor of Mechanical Engineering, Brooklyn Polytechnic Institute, Brooklyn, N. Y. 1927

Sette, Francis J., Deputy Director, Transportation and Storage, W.P.B., 4701 Conn. Ave., Apt. 502, Washington, D. C. 1925

Seulberger, Ferdinand G., Dean of Students, Northwestern Technological Institute, Evanston, Ill. 1940

Severance, Carlton S., Engineering Instructor, U.S.M.S. Candidates Training School, 50 Bulkley Ave., Sansalite, Calif. 1943

Severance, Donald P., Assistant Registrar, Massachusetts Institute of Technology, Cambridge, Mass. 1943

Severns, William H., Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1934

Seward, H. L., Robert Higgin Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1910

Sexton, F. H., President, Nova Scotia Technical College, Halifax, Nova Scotia 1908

Shaffer, Harold A., Assistant Professor of Electrical Engineering and Drawing, Bucknell University, Lewisburg, Pa. 1927

SHAFFER, ROBERT E., Instructor in Mechanical Engineering, Iowa State College, Ames, Iowa 1943
SHALLENBERGER, WILLIAM H., Assistant Professor of Mechanical Engineering, University of Southern California, Los Angeles, Calif. 1940
SHANK, JACOB RALPH, Professor of Civil Engineering, The Ohio State University, Columbus, Ohio 1919
SHANLEY, F. R., Division Engineer, Lockheed Aircraft Corp., Burbank, Calif. 1943
SHAPIRO, ARCHER H., Assistant Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943
SHARP, H. OAKLEY, Professor of Geodesy and Transportation Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1935
SHAVER, ROBERT E., Associate Professor of Civil Engineering, University of Kentucky, Lexington, Ky. 1943
SHAW, CLYDE E., Head, Dept. of Electrical Engineering, Tri-State College, Angola, Ind. 1942
SHAW, G. REED, Assistant Professor of Geodesy and Transportation, Rensselaer Polytechnic Institute, Troy, N. Y. 1940
SHEDD, PAUL C., Associate Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. 1928
SHEDD, THOMAS C., Professor of Structural Engineering, University of Illinois, Urbana, Ill. 1925
SHEERAR, LEONARD F., Associate Professor of Chemical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1943
SHEIRY, EDWARD S., Chief Engineer of Designs, Companhia Vale Do Rio Doce Av. Graca Aranha, 182 6°, Rio de Janeiro, Brazil 1928
SHELTON, EDWARD E., Instructor in Electrical Engineering, Cooper Union, New York City 1942
SHENK, D. H., Associate Professor of Mechanical Engineering, University of Alabama, University, Ala. 1928
SHEPHERD, MARSHAL L., Assistant Professor of Military Science and Tactics, North Carolina State College, Raleigh, N. C. **In military service** 1944
SHEPPARD, H. S., Apparatus Staff Engineer, Bell Telephone Labs., Inc., 195 Broadway, New York, N. Y. 1914
SHEPPERD, WILLIAM B., Route 3, Wayzata, Minn. 1943
SHERLOCK, ROBERT H., Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1925
SHERMAN, GEORGE W., JR., Associate Professor of Metallurgy, Purdue University, Lafayette, Int. 1929
SHERMAN, WILSON R., Lt. Comdr. USNR, Training Division, Bureau of Navy Personnel, Room 3721, Arlington Annex, Washington, D. C. **In military service** 1943
SHERRILL, RICHARD E., Professor and Head, Dept. of Oil and Gas, University of Pittsburgh, Pittsburgh, Pa. 1942
SHERWOOD, NOBLE P., Instructor in Mechanical Engineering, University of Wisconsin, Madison, Wis. 1941
SHERWOOD, ROBERT S., Instructor in Mechanical Engineering, Iowa State College, Ames, Iowa. **In military service** 1940
SHIELDS, BERT A., Lt. Comdr., USNR, Peru, Ind. **In military service** .. 1942
SHIELS, K. G., Associate Professor of Drawing and Descriptive Geometry, University of Wisconsin, Madison, Wis. 1937
SHIGLEY, JOSEPH E., Assistant Professor of Mechanical Engineering, Clemson College, Clemson, S. C. 1942

SHILTS, WALTER L., Head, Dept. of Civil Engineering, University of Notre Dame, Notre Dame, Ind. 1936
SHINE, BARTHOLOMEW J., Professor of Structural Engineering, University of Cincinnati, Cincinnati, Ohio 1943
SHIPLEY, E. D., Associate Professor of Electrical Engineering, University of Tennessee, Knoxville, Tenn. 1941
SHIRES, L. B., Associate Professor of Chemical Engineering, New Mexico State College, State College, N. M. 1940
SHOOK, PAUL S., Assistant Professor in charge of Engineering Drawing, Swarthmore College, Swarthmore, Pa. 1944
SHOOP, C. F., Professor and Head, Division of Steam Engineering, University of Minnesota, Minneapolis, Minn. 1906
SHOREY, LAWRENCE F., Assistant Professor of Electrical Engineering, University of Vermont, Burlington, Vt. 1926
SHORT, BRYON E., Professor of Mechanical Engineering, University of Texas, Box 1659, Univ. Sta., Austin, Texas 1931
SHORT, W. IRWIN, Associate Professor of Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. **In military service** 1934
SHREVE, DARRELL R., Stress Analyst, McDonnell Aircraft Co., St. Louis Mo. 1940
SHREVE, R. NORRIS, Professor of Chemical Engineering, Purdue University, Lafayette, Ind. 1930
SHUMAKER, CLIFFORD H., Associate Professor of Mechanical Engineering, Southern Methodist University, Dallas, Texas 1943
SHURTER, ROBERT L., Associate Professor of English, Case School of Applied Science, Cleveland, Ohio 1943
SHUTTS, WILLIAM H., Instructor in Mechanical Engineering, University of Colorado, Boulder, Colo. 1943
SHYBEKAY, DERSO S., Professor of Industrial Engineering, Purdue University, Lafayette, Ind. 1942
SIBILA, KENNETH F., Assistant Professor of Electrical Engineering, University of Akron, Akron, Ohio 1941
SIBLEY, ALDEN K., Engineer of Construction, U. S. Engineers Office, Massena, N. Y. **In military service** 1940
SIEGFRIED, VICTOR, Chief Research Engineer, American Steel & Wire Co., Worcester, Mass. 1934
SIEPERT, ALBERT F., Dean of Education, Bradley Polytechnic Institute, Peoria, Ill. 1942
SILHA, HENRY W., Assistant Professor of Mechanical Engineering, University of Idaho, Moscow, Idaho 1941
SILVERMAN, JOSEPH R., Chief Production Structural Engineer, Chance Vought Aircraft Div. of United Aircraft Corp., 97 Englewood Ave., Bridgeport, Conn. 1943
SILVEY, O. W., Professor and Head, Dept. of Physics, A. & M. College of Texas, College Station, Tex. 1917
SIMARD, JEAN-MARCEL, Assistant Professor of Chemistry, Ecole Polytechnique, Montreal, Canada 1942
SIMESTER, JOHN H., Associate Professor of Mathematics, University of Louisville, Louisville, Ky. 1930
SIMMONS, ALLEN, Associate Professor of Mathematics, Bethany College, Bethany, W. Va. 1942
SIMON, GEORGE H., Associate Professor of Mechanical Engineering, Louisiana State University, University, La. 1935
SIMON, HERBERT A., Assistant Professor of Political Science, Illinois Institute of Technology, Chicago, Ill. 1942

SIMONDS, ROLLIN H., Instructor in Industrial Engineering, Illinois Institute of Technology, Chicago, Ill. 1942
SIMONS, HOWARD P., Associate Professor of Chemical Engineering, West Virginia University, Morgantown, W. Va. 1941
SIMPSON, WILLIAM M., Professor and Chairman, Dept. of Aeronautical Engineering, University of Kansas, Lawrence, Kansas 1939
SIMRALL, HARRY C., Associate Professor of Electrical Engineering, Assistant to Director of Instruction, Mississippi State College, State College, Miss. 1936
SIMS, CHARLES E., Lecturer in Civil Engineering, University of Southern California, Los Angeles, Calif. 1941
SIMS, ELLIS M., Professor of Mechanical Engineering, University of Oklahoma, Norman, Okla. 1937
SIMS, JAMES R., Instructor in Civil Engineering, The Rice Institute, Houston, Texas 1942
SINGER, FERDINAND L., Assistant Professor of Engineering Mechanics, New York University, New York, N. Y. 1930
SINGSTAD, OLE, Chief Engineer, New York City Tunnel Authority, 200 Madison Ave., New York City 1944
SISKIND, ROBERT P., Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1938
SITZ, EARL L., Associate Professor of Electrical Engineering, Kansas State College, Manhattan, Kansas 1932
SIZELOVE, OLIVER J., Assistant Professor of Industrial Engineering, Newark College of Engineering, Newark, N. J. 1941
SKELLEY, CHARLES L., Manager, Technical Book Dept., The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. 1940
SKELTON, RUSSELL R., Associate Professor of Civil Engineering, University of New Hampshire, Durham, N. H. 1936
SKILES, W. V., Dean, Georgia School of Technology, Atlanta, Ga. 1919
SKOGLUND, VICTOR J., 4939 Canterbury Dr., San Diego, Calif. 1938
SKRODER, CARL E., Assistant Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1944
SLACK, EDGAR P., Associate Professor of Physics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1927
SLACK, FRANCIS G., Professor and Chairman, Dept. of Physics, Vanderbilt University, Nashville, Tenn. 1925
SLANTZ, FRED W., Professor of Graphics, Director of Placement, Lafayette College, Easton, Pa. 1930
SLAVIN, WILLIAM A., Associate Professor of Electrical Engineering Villanova College, Villanova, Pa. 1939
SLAYMAKER, P. K., Professor of Machine Design, University of Nebraska, Lincoln, Nebr. 1910
SLAYMAKER, ROBERT R., Dean, Junior Division, Professor of Machine Design, Case School of Applied Science, Cleveland, Ohio 1937
SLICHTER, W. I., Professor Emeritus, Electrical Engineering, Columbia University, New York, N. Y. 1911
SLOAN, ROYAL D., Dean, College of Mechanic Arts and Engineering, State College of Washington, Pullman, Wash. 1926
SLOAN, WILLIAM A., Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. 1937
SLOANE, ALVIN, Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1927
SLOANE, RICHARD L., Assistant Professor of Civil Engineering, University of Utah, Salt Lake City, Utah 1943

SLUSS, A. H., Professor of Mechanical Engineering, University of Kansas, Lawrence, Kans. 1915

SMAIL, LLOYD L., Professor of Mathematics, Lehigh University, Bethlehem, Pa. 1936

SMALL, ERIC H., Instructor in Electrical Engineering, New York University, New York, N. Y. 1938

SMITH, ALVA L., Assistant Professor of Civil Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1942

SMITH, EARL B., Professor of Mechanical Engineering, College of City of New York, New York, N. Y. 1926

SMITH, EDWARD F., Associate Professor of Electrical Engineering, University of Florida, Gainesville, Fla. 1935

SMITH, EDWARD S., Professor of Mathematics, University of Cincinnati, Cincinnati, Ohio 1944

SMITH, ELLIOTT D., Master, Saybrook College, Professor of Economics, Yale University, New Haven, Conn. 1928

SMITH, ELMER G., Professor of Physics, A. & M. College of Texas, College Station, Texas 1938

SMITH, FRANK H., Assistant Professor of Mechanism and Engineering Drawing, University of Michigan, Ann Arbor, Mich. **In military service** 1939

SMITH, FINLEY W., Associate Professor of Electrical Engineering, Lafayette College, Easton, Pa. 1933

SMITH, GEORGE B., Eastman Kodak Co., 343 State St., Rochester, N. Y. 1939

SMITH, GEORGE L., Associate Professor of Civil Engineering, University of Notre Dame, Notre Dame, Ind. 1942

SMITH, G. WALLACE, Professor and Head, Dept. of Engineering Mechanics, North Carolina State College, Raleigh, N. C. 1937

SMITH, HOMER P., Technical Employment Dept., Bell Telephone Labs., 463 West St., New York 11, N. Y. 1941

SMITH, JAMES H., Assistant Professor of Electrical Engineering, Cornell University, Ithaca, N. Y. 1940

SMITH, JAMES O., Associate in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. **In military service** . 1940

SMITH, LEO F., Associate Supervisor Evening School, Rochester Institute of Technology, Rochester, N. Y. 1944

SMITH, MARVIN W., Vice President in charge of Engineering, Westinghouse E. & M. Co., Pittsburgh, 30, Pa. 1942

SMITH, MAURICE E., Professor of Chemistry, Worcester Polytechnic Institute, Worcester, Mass. 1943

SMITH, OTTO J. M., Research Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa. 1942

SMITH, OTTO M., Professor of Chemical Engineering, Head, Dept., Chemistry and Chemical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1940

SMITH, PAUL C., Associate Professor of Electrical Engineering, University of Akron, Akron, Ohio 1925

SMITH, RALPH A., Instructor in Mechanical Engineering, Tufts College, Medford, Mass. 1922

SMITH, RICHARD H., Professor of Aeronautic Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1933

SMITH, ROGER K., Assistant Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1939

SMITH, SILAS R., R. R. 3, Anderson, Ind. **In military service** 1939

Smith, Thomas D., Assistant Professor of Civil Engineering, University of Delaware, Newark, Del. 1938

Smith, William C., Assistant Professor of Electrical Engineering, University of Maryland, College Park, Md. 1943

Smith, W. Sherman, Assistant Professor of Civil Engineering, Toledo University, Toledo, Ohio 1930

Smutz, F. A., Professor of Engineering Drawing and Descriptive Geometry, Kansas State College, Manhattan, Kansas 1936

Snader, David L., Professor of Civil Engineering, Stevens Institute of Technology, Hoboken, N. J. 1939

Snelgrove, Alfred K., Professor and Head, Dept. of Geological Engineering, Michigan College of M. & T., Houghton, Mich. 1943

Snook, Raymond C., Assistant Professor of Machine Design, Alabama Polytechnic Institute, Auburn, Ala. 1942

Snyder, John S., Assistant Manager, Educational Dept., John Wiley & Sons, Inc., 440 Fourth Ave., New York City 1943

Snyder, M. K., Head, Dept. of Civil Engineering, Professor of Sanitary Engineering, Washington State College, Pullman, Wash. 1927

Sobey, Albert, Director, General Motors Institute of Technology, Flint, Mich. 1923

Soderberg, C. Richard, Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1943

Soderstrom, E. D., Associate Professor of Engineering Shop, Oklahoma A. & M. College, Stillwater, Okla. 1940

Sohon, Harry, Assistant Professor of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa. 1942

Solberg, Harry L., Head, School of Mechanical and Aeronautical Engineering, Purdue University, Lafayette, Ind. 1924

Sollenberger, Norman J., Assistant Professor of Civil Engineering, Princeton University, Princeton, N. J. 1936

Solt, Marvin R., Associate Professor of Mathematics, University of New Hampshire, Durham, N. H. 1931

Soltau, David L., Director, Science Division, Professor of Physics, University of Redlands, Redlands, Calif. 1943

Sorensen, Elmer P., President, Utilities Engineering Institute, 1314 Belden Ave., Chicago, Ill. 1943

Sorensen, Harry A., Associate Professor of Mechanical Engineering, Pennsylvania State College, State College, Pa. 1938

Sorensen, R. W., Professor of Electrical Engineering, California Institute of Technology, Pasadena, Calif. (*Vice President, 1939–40; Member of Council 1937–40.*) 1912

Sorenson, Alfred E., Associate Professor of Mechanical Engineering, Princeton University, Princeton, N. J. 1931

Spacie, Edwin G., Assistant Professor of Mathematics and Physics, Michigan College of M. & T., Houghton, Mich. 1944

Spafford, W. F., Professor and Head, Dept. of Business Administration, Rensselaer Polytechnic Institute, Troy, N. Y. 1941

Spagnuolo, Joseph E., Assistant Professor of Architectural Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1939

Spahr, Robert H., Administrative Chairman, Division of Cooperative Programs, General Motors Institute of Technology, Flint, Mich. (*Member of Council, 1943–46.*) 1928

Sparks, Fred W., Professor of Mathematics, Texas Technological College, Lubbock, Texas 1940

SPEAR, JOSEPH, Professor and Chairman, Dept. of Mathematics, Northeastern University, Boston, Mass. 1926
SPEARS, SHOLTO M., Associate Professor of Civil Engineering, Illinois Institute of Technology, Chicago, Ill. In military service . 1935
SPEAS, ROBERT D., Assistant to the Vice President of Engineering, American Airlines, Inc., Jackson Heights, N. Y. 1943
SPEIDEN, HENRY W., Head, Dept. of Civil Engineering, West Virginia University, Morgantown, W. Va. 1937
SPENCE, THOMAS R., Manager, Construction Program, A. & M. College of Texas, College Station, Texas 1942
SPENCER, ERNEST L., Assistant Professor of Civil Engineering, Northeastern University, Boston, Mass. 1944
SPENCER, HENRY C., Chairman, Dept. of Technical Drawing, Illinois Institute of Technology, Chicago, Ill. 1931
SPENCER, HERBERT L., President, Bucknell University, Lewisburg, Pa. ... 1942
SPENCER, MARIE W., Instructor in History and Economics, Illinois Institute of Technology, Chicago, Ill. 1943
SPENCER, ROBERT L., Dean of Engineering, University of Delaware, Newark, Del. (*Member of Council, 1942–45.*) 1928
SPENCER, W. R., Professor of Civil Engineering, University of Arkansas, Fayetteville, Ark. 1926
SPICER, WILLIAM M., Associate Professor of Chemistry, Georgia School of Technology, Atlanta, Ga. 1944
SPIEGEL, DAVID K., Instructor in Economics of Engineering, Stevens Institute of Technology, Hoboken, N. J. 1943
SPINDLER, WILLIAM A., Assistant Professor of Metal Processing, University of Michigan, Ann Arbor, Mich. 1940
SPINNEY, L. B., Professor of Physics, Iowa State College, Ames, Ia. 1899
SPOTTS, MERHYLE F., Associate Professor of Machine Design, Northwestern University, Evanston, Ill. 1943
SPRIEGEL, WILLIAM R., Professor and Chairman, Dept. of Management, Northwestern University, Evanston, Ill. 1940
SPRINGER, CLIFFORD H., Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. 1927
SPRINGER, GEORGE P., Associate Professor of Civil Engineering, Purdue University, Lafayette, Ind. 1930
SPRY, FREDERICK J., Instructor in Surveying, Cornell University, Ithaca, N. Y. 1941
SPURLOCK, BENJAMIN H., Assistant Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1940
SQUIRE, EDWARD J., Professor and Head, Dept. of Structural Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1929
ST. CLAIR, O. A., Professor and Head, Dept. of Industrial Engineering, Texas Technological College, Lubbock, Texas 1934
ST. PETER, W. N., Professor of Physics, University of Pittsburgh, Pittsburgh, Pa. 1928
STACE, F. N., Editor, New Zealand Electrical Journal, P.O. Box 1572, Wellington, C 1, N. Z. 1939
STAINTON, ROBERT S., Associate Professor of Industrial Engineering, Bradley Polytechnic Institute, Peoria, Ill. 1941
STALEY, HOWARD R., Assistant Professor of Building Construction, Massachusetts Institute of Technology, Cambridge, Mass. 1940
STANLEY, CASSIUS M., Professor and Head, Dept. of Textile Engineering, Texas Technological College, Lubbock, Texas 1941

STANLEY, ROBERT L., Assistant Professor of Civil Engineering, Union College, Schenectady, N. Y. 1942
STANLEY, WILLIAM E., Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1936
STANTON, CHAS. B., Supervisor, Evening and Part Time Classes and Summer Session, Carnegie Institute of Technology, Pittsburgh, Pa. 1915
STAPLES, ARTHUR J., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1934
STAPLEY, EDWARD R., Professor of Civil Engineering, Acting Dean, Oklahoma A. & M. College, Stillwater, Okla. 1926
STARK, LAWRENCE E., Instructor in Engineering Drawing, A. & M. College of Texas, College Station, Texas 1942
STARR, CHARLES J., Associate in Mechanical Engineering, University of Illinois, Urbana, Ill. 1921
STARR, MILLARD O., Instructor in General Engineering Drawing, University of Illinois, Urbana, Ill. 1943
STAUDER, LAWRENCE F., Associate Professor of Electrical Engineering, University of Notre Dame, Notre Dame, Ind. 1938
STAVELY, EARL B., Professor of Electrical Engineering, The Pennsylvania State College, State College, Pa. 1920
STEARNS, FREDERICK A., Associate Professor of Mechanical Engineering, Northeastern University, Boston, Mass. 1926
STEEL, ERNEST W., Professor and Head, Dept. of Municipal and Sanitary Engineering, A. & M. College of Texas, College Station, Texas . 1926
STEELE, ARLO L., Instructor in Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. **In military service** 1940
STEIN, I. MELVILLE, Vice President and Director of Research, Leeds and Northrup Co., Philadelphia, Pa. 1944
STEINBACHER, FRANZ R., Assistant Professor of Aeronautics, University of Michigan, Ann Arbor, Mich. 1943
STEINBERG, S. S., Dean, College of Engineering, University of Maryland, College Park, Md. 1935
STEINMAN, D. B., Consulting Engineer, 117 Liberty St., New York, N. Y. 1910
STELZNER, WILLIAM B., Professor and Head, Dept. of Electrical Engineering, University of Arkansas, Fayetteville, Ark. 1914
STEMPEL, W. M., Assistant Professor of Physics, Stevens Institute of Technology, Hoboken, N. J. 1928
STEPHANS, C. H., Acting Head, Industrial Relations Dept., Newark College of Engineering, Newark, N. J. 1943
STEPHENSON, EUGENE A., Professor and Head, Dept. of Petroleum Engineering, University of Kansas, Lawrence, Kansas 1938
STETKEWICZ, JOSEPH D., Associate Professor of Mechanical Engineering, Rutgers University, New Brunswick, N. J. 1942
STETSON, GEORGE A., Editor, American Society of Mechanical Engineers, 29 West 39th Street, New York City. (*Member of Council, 1931–4.*) 1926
STEVASON, CARL C., Assistant Professor of Engineering Drawing, Notre Dame University, Notre Dame, Ind. 1942
STEVENS, A. C., Manager, Educational Sales Section, General Electric Co., Schenectady, N. Y. 1912
STEVENS, DON S., Engineering Personnel Officer, Iowa State College, Ames, Iowa. **In military service** 1938
STEVENS, HOWARD E., Associate Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1934
STEVENS, ROE L., Associate Professor of Civil Engineering, Illinois Institute of Technology, Chicago, Ill. 1937

STEVENS, WILLIAM J., Associate Professor of Mechanical Engineering, Drexel Institute, Philadelphia, Pa. 1929
STEVENSON, ALEXANDER R., JR., Staff Assistant to Vice President in Charge of Engineering, General Electric Co., Schenectady, N. Y. ... 1938
STEVENSON, MERLON L., Dean of Instruction, Weber College, Ogden, Utah 1943
STEVENSON, WILLIAM D., Assistant Professor of Electrical Engineering, Princeton University, Princeton, N. J. 1941
STEWART, EARL H., Assistant Professor of Drawing and Design, Michigan State College, East Lansing, Mich. 1925
STEWART, G. W., Professor and Head, Dept. of Physics, State University of Iowa, Iowa City, Ia. 1910
STEWART, JAMES W., Assistant Professor of Mining Engineering, University of Illinois, Urbana, Ill. 1939
STEWART, LOWELL O., Professor and Head, Dept. of Civil Engineering, Iowa State College, Ames, Iowa 1927
STEWART, V. T., Professor of Chemistry, Newark College of Engineering, Newark, N. J. 1923
STIFFEL, KARL J., Engineer, Raytheon Mfg. Co., Waltham, Mass. 1940
STIEMKE, ROBERT E., Associate Professor of Sanitary Engineering, North Carolina State College, Raleigh, N. C. 1943
STIENING, FRANK H., Professor and Head, Dept. of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1940
STILES, WILLIAM B., Assistant Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa 1938
STILLWELL, HENRY S., Professor and Head, Dept. of Aeronautical Engineering, University of Kansas, Lawrence, Kans. 1944
STINSON, KARL W., Professor of Internal Combustion Engines, The Ohio State University, Columbus, Ohio 1924
STIPE, C., GEORGE, Associate Professor of Mathematics and Surveying, Michigan College of M. & T., Houghton, Mich. 1943
STITZ, ERWIN O., Assistant Professor of Engineering Mechanics, Purdue University, Lafayette, Ind. 1942
STOCK, ORION L., Professor of Drawing and Descriptive Geometry, Rose Polytechnic Institute, Terre Haute, Ind. 1929
STOCKER, GEORGE P., Dean, College of Engineering, Head, Dept. of Civil Engineering, University of Arkansas, Fayetteville, Ark. 1921
STOCKING, ERNEST J., Assistant Chief, Examining Division, U. S. Civil Service Commission, Washington, D. C. 1939
STOCKWELL, FRANK C., Anson Wood Burchard Professor of Electrical Engineering, Stevens Institute of Technology, Hoboken, N. J. 1914
STOEVER, HERMAN J., Professor of Mechanical Engineering, Iowa State College, Ames, Iowa 1942
STOKER, JAMES J., Associate Professor of Mathematics, New York University, New York City 1938
STOLWORTHY, EDWARD H., Associate Professor of Mechanical Engineering, University of New Hampshire, Durham, N. H. 1923
STONE, OLIVER M., Associate Professor of Engineering Drawing, Case School of Applied Science, Cleveland, Ohio 1928
STONE, ROBERT L., Associate Professor of Ceramics Engineering, North Carolina State College, Raleigh, N. C. 1937
STORK, WILFORD L., Associate Professor of Drafting, College of the City of New York, New York City 1939
STOUT, LAWRENCE E., Professor and Head, Dept. of Chemical Engineering, Washington University, St. Louis, Mo. 1944

STOUT, MELVILLE B., Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. 1929

STRAITON, A. W., Associate Professor of Electrical Engineering, University of Texas, Austin, Texas 1939

STRALEY, HARRISON W., Johnson & Straley, Princeton, W. Va. 1939

STRANE, ARCHIBALD J., Instructor and Head, Mathematics Dept., Duluth Junior College, Duluth 14, Minn. 1932

STRATE, J. TAYLER, Professor and Head, Dept. of Mechanical Engineering, Colorado State College, Ft. Collins, Colo. 1932

STRATTON, LEON D., Professor and Head, Dept. of Chemical Engineering, Dean of Men, Drexel Institute of Technology, Philadelphia, Pa. 1937

STRATTON, WILLIAM T., Professor and Head, Dept. of Mathematics, Kansas State College, Manhattan, Kansas 1938

STRAUB, LORENZ G., Professor of Hydraulics, Director, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minn. (*Member of Council, 1939–42.*) 1929

STRAW, JOHN A., Instructor in Mathematics, Rose Polytechnic Institute, Terre Haute, Ind. 1939

STREET, WILLIAM E., Professor and Head, Dept. of Engineering Drawing, Texas A. & M. College, College Station, Texas 1929

STREETER, VICTOR L., Supervisor of Fluid Mechanics, Armour Research Foundation, Chicago 16, Ill. 1942

STREUBEL, ERNEST J., Dean, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1925

STROBEL, CHARLES F., Assistant Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1941

STROHM, RUFUS T., Vice President, Dean of the Faculty, International Correspondence School, Scranton, Pa. 1938

STROM, GORDON H., Assistant Professor of Aeronautical Engineering, New York University, New York City 1943

STRONG, EVERETT M., Professor of Electrical Engineering, Cornell University, Ithaca, N. Y. 1939

STRONG, RALPH K., Professor of Chemistry and Chemical Engineering, Rose Polytechnic Institute, Terre Haute, Ind. 1936

STUART, HARLAND F., Assistant Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. 1942

STUART, M. C., Professor of Mechanical Engineering, Lehigh University, Bethlehem, Pa. 1921

STUBBS, FRANK W., JR., Professor and Head, Dept. of Civil Engineering, Rhode Island State College, Kingston, R. I. 1933

STUCKEY, JASPER L., Professor and Head, Dept. of Geology and Geological Engineering, North Carolina State College, Raleigh, N. C. .. 1939

STURGIS, HORACE W., Instructor in Physics, Georgia School of Technology, Atlanta, Ga. 1944

STURM, ROLLAND G., Professor of Engineering Mechanics and Research Professor of Materials, Purdue University, Lafayette, Ind. 1944

STURMER, ANNA M., Associate Professor of English, Kansas State College, Manhattan, Kansas 1935

STUTTERD, HENRY J., Chairman of Pre-Engineering, St. Mary's College, Saint Mary's College, Calif. 1943

SUCKOW DA FONSECA, CELSO, Director, Escola Tecnica Nacional, Rio de Janeiro, Brazil, S. A. 1943

SULLIVAN, FRANCIS J., Instructor in Machine Design, Kansas State College, Manhattan, Kansas. In military service 1938

SULLIVAN, GEO. L., Dean, College of Engineering, University of Santa Clara, Santa Clara, Calif. (*Member of Council, 1943–46.*) 1912

SUMMERS, ROBERT E., Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 1939

SUMMEY, GEORGE, JR., Professor of English, A. & M. College of Texas, College Station, Tex. 1919

SUMWALT, ROBERT L., Dean, School of Engineering, University of South Carolina, Columbia, S. C. 1933

SUNDQUIST, FREDERICK R. C., Associate Educational Officer, Engineering, U. S. Merchant Marine Cadet Corps, 213 Middleneck Road, Great Neck, N. Y. 1944

SUNSHINE, IRVING, Instructor in Chemistry, Newark College of Engineering, Newark, N. J. 1943

SUPPLE, LEE F., Professor of Chemistry,, Illinois Institute of Technology, Chicago, Ill. 1939

SUTHERLAND, [illegible] Professor and Head, Dept. of Civil Engineering, Lehigh University, Bethlehem, Pa. 1914

SUTTIE, RO[illegible], Professor of Civil Engineering, Yale University, New Haven, Conn. 1912

SUTTON, CH[illegible], Associate Professor of Architecture, The Ohio State University, Columbus, Ohio 1943

SVENSEN, CA[illegible], Secretary, Texas State Board of Registration for Professional Engineers, 511 Ewell Nolle Bldg., Austin, Texas 1909

SVENSON, C[illegible] Associate Professor of Heat Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1937

SWAIM, VERNE F., Professor and Head, Dept. of Physics, Bradley Polytechnic Institute, Peoria, Ill. 1919

SWANSON, HARRY [illegible], Assistant Professor of Civil Engineering, North Dakota Agricultural College, Fargo, N. D. 1942

SWANTON, WALTER F., Instructor in Mathematics, U. S. Naval Academy, Annapolis, Md. **In military service** 1944

SWARTZ, BLAIR K., Supervisor of Personnel Research, Detroit Edison Company, Detroit, Mich. 1931

SW[illegible], O. R., Professor and Head, Dept. of Chemical Engineering, Iowa State College, Ames, Iowa 1934

SW[illegible], F. O., Professor of Civil Engineering, Washington University, St. Louis, Mo. 1910

[illegible], RAY L., Professor of Mechanical Engineering, Director, General Engineering, Georgia School of Technology, Atlanta, Ga. (*Member of Council, 1936–39.*) 1929

SWENSON, GEORGE W., Professor and Head, Department of Electrical Engineering, Michigan College of Mining and Technology, Houghton, Mich. 1928

SWETT, GEORGE W., Professor of Machine Design, Massachusetts Institute of Technology, Cambridge, Mass. 1933

SWI[illegible], ROY E., 1327 E. 4th, South, Salt Lake City 2, Utah 1940

SWIN[illegible]D, CHARLES R., Associate Professor of Machine Design, Illinois Institute of Technology, Chicago, Ill. 1935

SY[illegible], J. L., Professor of Mathematics, The Ohio State University, Columbus, Ohio 1943

SYPHERD, W. O., Acting President, Professor of English, University of Delaware, Newark, Del. 1914

TA[illegible], THEODORE H., Associate Professor of Heat Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1926

TAGGART, ARTHUR F., Professor of Mineral Dressing, Columbia University, New York City 1938

TAIT, RALPH S., Associate Professor of Mechanical Engineering, University of Kansas, Lawrence, Kans. 1921

TALMAGE, S. B., Consulting Geologist, Salt Lake City, Utah 1932

T'ANG, CHEN-HSU, Engineer and Liaison Secretary, Universal Trading Corp, New York, N. Y. 1941

TANG, KWAN Y., Associate Professor of Electrical Engineering, The Ohio State University, Columbus, Ohio 1928

TAPPAN, FRANK G., Director, School of Electrical Engineering, University of Oklahoma, Norman, Okla. 1921

TAPY, RALPH W., Head, Dept. of Electrical Engineering, University of New Mexico, Albuquerque, N. M. 1934

TARBOUX, JOSEPH G., Professor of Electrical Engineering, University of Tennessee, Knoxville, Tenn. 1943

TARPLEY, CLARENCE E., Instructor in Engineering Mechanics, New York University, New York City 1943

TARPLEY, H. I., Associate Professor of Electrical Engineering, The Pennsylvania State College, State College, Pa. 1934

TASKIN, HALDUN K., Assistant Professor of Mechanical Engineering, Marquette University, Milwaukee. Wis. 1943

TATE, MANFORD B., Instructor in Civil Engineering, University of Missouri, Columbia, Mo. 1943

TATNALL, F. G., Manager, Testing Equipment Division, Baldwin-Southwark Corp., Paschall P. O., Philadelphia, Pa. 1935

TAULBEE, PRESTON J., Instructor in Science. U. S. Coast Guard Academy, New London, Conn. 1944

TAYLOR, ALBERT L., Dean, School of Mines and Engineering, Head, E. E. Dept., University of Utah, Salt Lake City, Utah 1938

TAYLOR, ALTON D., Visiting Lecturer in Civil Engineering, Northwestern University, Evanston, Ill. 1936

TAYLOR, BERNARD P., Assistant to the President, Illinois Institute of Technology, Chicago, Ill. 1942

TAYLOR, DELOS C., Assistant Professor of Applied Mechanics, Kansas State College, Manhattan, Kansas 193

TAYLOR, DONALD W., Associate Professor of Soil Mechanics, Massachusetts Institute of Technology, Cambridge, Mass. 1935

TAYLOR, FRANCIS M., Associate Professor of Chemical Engineering, Tulane University, New Orleans, La. 19

TAYLOR, FRANK M., Assistant Professor of Civil Engineering, University of Maine, Orono, Me. 1941

TAYLOR, HAROLD E., Acting Principal, Brooklyn Technical High School, Brooklyn, N. Y. 1944

TAYLOR, KARL V. Assistant Professor of Civil Engineering, The Citadel, Charleston, S. C. 1943

TAYLOR, WALTER A., Assistant Professor of Architecture, Syracuse University, Syracuse, N. Y. 1941

TAYLOR, W. C., Professor of Civil Engineering, Union University, Schenectady, N. Y. 1913

TAYLOR, WILLIAM H., Professor of Drawing and Surveying, Supervisor, E. S. M. D. T., University of Alabama, University, Ala. 1942

TAYLOR, WILLIAM S., Professor of Chemistry, Georgia School of Technology, Atlanta, Ga. 1944

TEA, PETER L., Assistant Professor of Drafting, College of the City of New York, New York City 1935

TEAL, EVERETT A., Assistant Professor of Mechanical Engineering, University of Connecticut, Storrs, Conn. 1943
TEARE, B. RICHARD, JR., Professor and Head, Dept. of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 1933
TEICHMANN, F. K., Professor and Chairman, Dept. of Aeronautical Engineering, New York University, New York, N. Y. 1930
TEMPLE, EDWARD H., Head of Drafting Dept., Mechanic Arts High School, Boston, Mass. 1938
TEMPLE, VAN B., Professor of Mathematics and Engineering, Louisiana College, Pineville, La. 1943
TENNEY, EDWARD A., Associate Professor of English, Cornell University, Ithaca, N. Y. 1939
TERRELL, DANIEL V., Assistant Dean of Engineering, University of Kentucky, Lexington, Ky. 1917
TERRELL, WENDELL P., Assistant in Mechanical Dept., National Bureau of Standards, 1505 Tea St., N.W., Washington 9, D. C. 1944
TERWILLIGER, C. V. O., Professor and Head, Dept. of Electrical Engineering, Post Graduate School, U. S. Naval Academy, Annapolis, Md. 1924
THARRATT, GEORGE, General Manager, Lear Avia. of Calif., Inc., Hollywood, Calif. 1943
THATCHER, CHARLES G., Associate Professor of Mechanical Engineering, Swarthmore College, Swarthmore, Pa. 1929
THATCHER, ROMEYN Y., Associate Professor of Civil Engineering, Cornell University, Ithaca, N. Y. 1934
THEISS, E. S., Instructor in Mechanical Engineering, Duke University, Durham, N. C. 1939
THEROUX, FRANK R., Associate Professor of Civil Engineering, Michigan State College, East Lansing, Mich. 1938
THEURER, ELLEN K., In charge of Engineering Library, University of Michigan, Ann Arbor, Mich. 1943
THOM, GEORGE B., Associate Professor and Chairman, Dept. of Mechanical Engineering, Swarthmore College, Swarthmore, Pa. 1935
THOMAN, WM. H., Professor of Civil Engineering, University of Colorado, Boulder, Colo. 1940
THOMAS, ALBERT L., Professor of Engineering Drawing, Alabama Polytechnic Institute, Auburn, Ala. 1928
THOMAS, CHARLES F., Professor of Mathematics, Case School of Applied Science, Cleveland, O. 1909
THOMAS, D. BOYD, Instructor in Apprentice School, Newport News Shipbuilding & Dry Dock Co., Newport News, Va. 1938
THOMAS, EUGENE M., Dean of Engineering, Texas College of M. & M., El Paso, Texas 1944
THOMAS, EVAN, Professor of Mechanics and Mathematics, Emeritus, University of Vermont, 38 Winans St., East Orange, N. J. 1908
THOMAS, FRANKLIN, Professor of Civil Engineering, California Institute of Technology, Pasadena, Calif. 1914
THOMAS, FREDERICK H., Professor of Mechanical Engineering, University of Tennessee, Knoxville, Tenn. 1926
THOMAS, GEO. B., Personnel Director, Bell Telephone Laboratories, Inc., 463 West St., New York, N. Y. 1911
THOMAS, GILBERT D., Assistant Professor of Industrial Engineering, The Pennsylvania State College, State College, Pa. 1937
THOMAS, HAROLD A., Professor of Civil Engineering, Acting Head, Dept. of Mechanics, Carnegie Institute of Technology, Pittsburgh, Pa. 1913

THOMAS, LUTHER W., Instructor in Engineering Drawing, Purdue University, Lafayette, Ind. 1939
THOMAS, M. A., Professor and Head, Dept. of Electrical Engineering, New Mexico College of A. & M., State College, N. M. 1934
THOMAS, NEIL D., Assistant Professor of Civil Engineering, Ohio University, Athens, Ohio 1943
THOMPSON, H. LOREN, Assistant Professor of Civil Engineering, Northwestern University, Evanston, Ill. 1939
THOMPSON, J. GEORGE H., Associate Professor of Mechanical Engineering, Texas A. & M. College, College Station, Texas 1938
THOMPSON, JESSE N., Assistant Professor of Civil Engineering, University of Texas, Austin, Texas 1942
THOMPSON, JAMES S., President, McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. (*Treasurer, 1942–; Member of Council, 1938–.*) 1911
THOMPSON, JAMES S., Professor and Chairman, Dept. of Physics, Illinois Institute of Technology, Chicago, Ill. 1935
THOMPSON, JOSEPH T., Professor of Civil Engineering, The Johns Hopkins University, Baltimore, Md. 1941
THOMPSON, KARL O., Professor of English, Case School of Applied Science, Cleveland, O. 1919
THOMPSON, LEE P., Associate Professor of Mechanical Engineering, A. & M. College of Texas, College Station, Texas 1943
THOMPSON, M. J., Professor and Head, Dept. of Aeronautics, The University of Texas, Austin, Texas 1934
THOMPSON, PAUL V., Associate Professor of English, University of Colorado, Boulder, Colo. 1943
THOMPSON, SOPHUS, Professor of Civil Engineering, Southern Methodist University, Dallas, Texas 1936
THOMSON, FRANCIS A., President, Montana School of Mines, Butte, Mont. 1927
THORNBURG, MARTIN L., Professor and Head, Dept. of Mechanical Engineering, University of Arizona, Tucson, Ariz. 1925
THORNTON, JESSE E., Professor of English, University of Michigan, Ann Arbor, Mich. 1936
THOROGOOD, BRACKETT K., Director, Franklin Technical Institute, Boston, Mass. 1940
THRESHER, B. ALDEN, Director of Admissions, Associate Professor of Economics, Massachusetts Institute of Technology, Cambridge, Mass. .. 1935
THROOP, JOSEPH F., Instructor in Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y. 1943
THUESEN, H. G., Professor and Head, Dept. of Industrial Engineering, Oklahoma A. and M. College, Stillwater, Okla. 1926
TIBBALS, C. AUSTIN, Dean of Students, Illinois Institute of Technology, Chicago, Ill. 1935
TICE, LAWRENCE W., Manager, College Dept., International Textbook Co., Scranton, Pa. 1936
TILGHMAN, HARRISON, Counsellor at-Law, Foxly, Easton, Md. 1919
TILLER, FRANK M., Assistant Professor of Chemical Engineering, Vanderbilt University, Nashville, Tenn. 1944
TILLES, ABE, Assistant Professor of Electrical Engineering, University of California, Berkeley, Calif. 1937
TIMBIE, WILLIAM H., Professor of Electrical Engineering and Industrial Practice, Massachusetts Institute of Technology, Cambridge, Mass. (*Member of Council, 1929–32.*) 1908
TIMBY, ELMER K., Associate Professor of Civil Engineering, Princeton University, Princeton, N. J. In military service 1929

TIMOSHENKO, GREGORY S., Associate Professor of Electrical Engineering, University of Connecticut, Storrs, Conn. 1939

TIMOSHENKO, STEPHEN, Professor of Theoretical and Applied Mechanics, Stanford University, Stanford University, Calif. **Twelfth Recipient, Lamme Medal (1939)** .. . 1927

TINGLEY, FREEMAN T., Professor of Electrical Engineering, Clemson College, Clemson College, S. C. 1927

TIPPY, KENNETH C., Associate Professor of Civil Engineering, University of Connecticut, Storrs, Conn. 1943

TODD, M. E., Assistant Professor of Electric Power Engineering, University of Minnesota, Minneapolis, Minn. 1913

TODD, MARION W., Associate Professor of Topographical Engineering, Purdue University, Lafayette, Ind. 1926

TOMLINSON, GEORGE E., Senior Office Engineer, Tennessee Valley Authority; Lecturer in Civil Engineering, University of Tennessee, Knoxville, Tenn. **In military service** 1933

TOMPKINS, FREDERICK N., Associate Professor of Electrical Engineering, Brown University, Providence, R. I. 1922

TONKIN, JOHN C., Instructor in Mechanical Engineering, University of New Hampshire, Durham, N. H. 1935

TOPORECK, EDWARD R., Staff Member. D.I.C., Massachusetts Institute of Technology, Cambridge, Mass. 1939

TOPPING, ALANSON D., JR., 851 Work Drive, Akron 2, Ohio 1943

TORGERSEN, HAROLD, Assistant Professor of Electrical Engineering, New York University, New York City. **In military service** 1935

TORRANCE, CHARLES C., Assistant Professor of Mathematics, Case School of Applied Science, Cleveland, Ohio 1941

TOUR, R. S., Professor of Chemical Engineering, University of Cincinnati, Cincinnati, Ohio 1944

TOWLE, GEORGE W., Associate Professor of Coördination, Northeastern University, Boston, Mass. 1939

TOWLE, NORMAN L., Professor in charge of Electrical Engineering Dept., Cooper Union, New York City 1925

TOWN, GEORGE R., Manager of Engineering and Research, Stromberg-Carlson Co., Rochester, N. Y. 1944

TOWNSEND, ARTHUR L., Director, Lowell Institute School, Massachusetts Institute of Technology, Cambridge, Mass. 1933

TOWNSEND, CLARENCE E., Professor and Head, Dept. of Engineering Drawing, Cornell University, Ithaca, N. Y. 1930

TOWNSEND, ERNEST J., Assistant Professor of Civil and Mechanical Engineering and Economics, Michigan College of M. & T., Houghton, Mich. 1944

TOZER, ELIOT F., Professor of Drawing, Northeastern University, Boston, Mass. 1927

TRACY, GORDON F., Associate Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1928

TRACY, JOHN C., Emeritus Professor of Civil Engineering, Yale University, 345 Winthrop Ave., New Haven, Conn. (*Member of Council, 1912–5; 1920–3.*) 1907

TRACY, STEPHEN J., Assistant Professor of Mechanical Engineering, College of the City of New York, New York City 1930

TRATHEN, ROLAND H., Assistant Professor of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1935

TRENT, CLARENCE E., Assistant Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1938

TRIANA, JORGE, Dean, Facultad de Matematicas e Ingenieria, Universidad Nacional de Colombia, Bogota, Colombia, S. A. 1943

TRIEST, RUDOLPH M., Vice President, John Wiley and Sons, Inc., 440 Fourth Avenue, New York City 1924

TRIGGER, KENNETH J., Assistant Professor of Mechanical Engineering, University of Illinois, Urbana, Ill. 1936

TRIPP, WILSON, Associate Professor of Mechanical Engineering, Kansas State College, Manhattan, Kansas 1937

TRIVELY, ILO A., Assistant Professor of Civil Engineering, Clemson College, Clemson, S. C. 1942

TROTTER, RICHARD A., Associate Professor of Experimental Engineering, Georgia School of Technology, Atlanta, Ga. 1929

TROWBRIDGE, DOUGLAS S., Professor of Civil Engineering, New York University, New York City 1924

TROXELL, GEORGE E., Professor of Civil Engineering, University of California, Berkeley, Calif. 1940

TRUEBLOOD, RALPH B., Professor of Engineering Shop Practice, Purdue University, Lafayette, Ind. 1922

TRUEBLOOD, RICHARD O., Acting Head, Dept. of Electrical Engineering, University of Wyoming, Laramie, Wyo. 1931

TRUETTNER, W. I., Professor of Mechanical Engineering, A. & M. College of Texas, College Station, Texas 1938

TRUMMEL, JOHN M., Assistant Professor of Mechanical Engineering, University of Iowa, Iowa City, Iowa 1943

TRUMPLER, PAUL R., Development Engineer, M. W. Kellogg Co., New York City 1940

TSCHEBOTARIOFF, GREGORY P., Associate Professor of Civil Engineering, Princeton University, Princeton, N. J. 1937

TUCKER, CARLTON E., Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. (*Member of Council, 1942–45.*) 1922

TUCKER, J. MACK, Associate Professor of Mechanical Engineering, University of Tennessee, Knoxville, Tenn. 1943

TUCKER, LEROY, Associate Professor of Mechanics, The Ohio State University, Columbus, Ohio 1927

TUCKER, RAYMOND R., Professor of Mechanical Engineering, Washington University, St. Louis, Mo. 1943

TUCKER, SAMUEL M., Cornwall, N. Y. 1937

TUDBURY, CHESTER W., Head, Department of Mathematics, Wentworth Institute, Boston, Mass. 1921

TULLOSS, JOSEPH C., Professor of Engineering Drawing, Adult Education Foundation, 2223 W. 93rd St., E. Cleveland, 2, Ohio 1943

TULLY, THOMAS J., Assistant Professor in Charge of Purchases, Newark College of Engineering, Newark, N. J. 1943

TUMBLESON, IRA A., Librarian, Newark College of Engineering, Newark, N. J. 1943

TURKES, WALTER R., Associate Professor and Head, Dept. of Industrial Engineering, University of Pittsburgh, Pittsburgh, Pa. 1943

TURNBULL, W. D., Junior Dean, College of Engineering, The Ohio State University, Columbus, Ohio 1917

TURNEAURE, F. E., Dean Emeritus, University of Wisconsin, 116 No. Prospect Ave., Madison, Wis. (*President, 1908–9; Member of Council since 1903; Member, Board of Investigation and Coördination, 1925–33.*) **Tenth Recipient, Lamme Medal (1937)** 1894

Turner, Adlai S., Professor of Civil Engineering, Arkansas Polytechnic College, Russellville, Ark. **In military service** 1940
Turner, Arthur W., Assistant Chief, Bureau of Plant Industry, U. S. Dept. of Agriculture, Washington, D. C. 1943
Turner, Francis M., Vice President, The Reinhold Publishing Co., 330 West 42nd St., New York City 1942
Turner, Herbert M., Associate Professor of Electrical Engineering, Yale University, New Haven, Conn. 1929
Turner, Richard C., Jr., Dept. of Electrical Engineering, U. S. Naval Academy, Annapolis, Md. **In military service** 1938
Turner, William W., Head, Dept. of Engineering Drawing, University of Notre Dame, Notre Dame, Ind. 1939
Tuthill, Arthur F., Instructor in Mechanical Engineering, Cooper Union, New York City. **In military service** . 1939
Tuthill, John K., Associate Professor of Railway Electrical Engineering, University of Illinois, Urbana, Ill. 1922
Tutt, Charles L., Associate Editor, Product Engineering, McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. 1941
Tuve, George L., Professor of Heat-Power Engineering, Case School of Applied Science, Cleveland, Ohio 1925
Tweney, G. H., Acting Director, Dept. of Aeronautics, University of Detroit, Detroit, Mich. 1941
Twogood, A. J., Instructor in Engineering, Riverside Junior College, Riverside, Calif. 1933
Tykociner, Joseph T., Research Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1929
Tyler, Edward J., Director, College Department, Harper & Brothers, Publishers, 49 E. 33rd St., New York City 1940
Tyrrell, Cecil C., 115 School Lane, Springfield, Pa. 1934
Uhler, Eugene H., Assistant Professor of Civil Engineering, Lehigh University, Bethlehem, Pa. 1936
Uicker, John J., Assistant Professor and Acting Director, Dept. Mechanical Engineering, University of Detroit, Detroit, Mich. 1933
Underhill, James, Associate Professor of Mining, Colorado School of Mines, Golden, Colo. 1921
Underwood, P. H., Professor of Surveying, Cornell University, Ithaca, N. Y. 1922
Updegrove, Henry T., Jr., Instructor in Mechanical Engineering, College of the City of New York, New York City 1938
Upp, Clarence R., Associate Professor of Mechanical Engineering, University of Akron, Akron, Ohio 1928
Upthegrove, Clair, Professor of Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. 1940
Uren, Lester C., Professor of Petroleum Engineering, University of California, Berkeley, Calif. 1939
Vacha, Fred, Development Engineer, The Holtzer Cabot Electric Co., Boston, Mass. 1932
Vagtborg, Harold A., President, Midwest Research Institute, Kansas City, Mo. 1936
Vail, Charles R., Instructor in Electrical Engineering, Duke University, Durham, N. C. 1940
Vail, Robert P., Head of Mechanical Engineering, Pantex Ordnance Plant, Amarillo, Texas 1938
Vaile, Robert B., Assistant Professor of Electrical Engineering, University of Missouri, Columbia, Mo. 1937

VALADE, ERNEST A., Associate Professor of Electrical Engineering, Catholic University of America, Washington, D. C. 1936
VANCE, HAROLD, Professor and Head, Dept. of Petroleum Engineering, A. & M. College of Texas, College Station, Texas 1937
VAN DEN BROEK, J. A., Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. 1924
VANDER VELDE, THEODORE L., Sanitary Engineer, Mich. Dept. of Health, 2609 E. Saginaw St., Lansing, Mich. 1938
VAN DRIEST, EDWARD R., Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1942
VAN DYKE, JAMES R., Acting Head, Dept. of Mechanical Engineering, University of Nevada, Reno, Nev. 1941
VAN GORDON, J. H., Chairman, Division of Engineering Education, Business Machines Corp., Endicott, N. Y. 1943
VAN HAGAN, L. F., Professor and Chairman, Dept. of Civil Engineering, University of Wisconsin, Madison, Wis. 1912
VAN HOUTEN, ROBERT W., Dean, Newark College of Engineering, Newark, N. J. 1933
VAN LEER, BLAKE R., President, Georgia School of Technology, Atlanta, Ga. (*Member of Council, 1933–36.*) 1923
VANNOTE, ROBERT L., Assistant to the President, Newark College of Engineering, Newark, N. J. 1943
VAN NOTE, WILLIAM G., Professor of Metallurgy, North Carolina State College, Raleigh, N. C. 1936
VAN PELT, JOHN R., Technical Director, Museum of Science and Industry, Jackson Park at 57th St., Chicago, 37, Ill. 1936
VAN SICKLE, CLARENCE L., Professor of Accounting, University of Pittsburg, Pittsburgh, Pa. 1943
VAN VALKENBURG, MAC E., Staff Member, Radiation Lab., Massachusetts Institute of Technology, Cambridge, Mass. 1941
VAN VLACK, CLAUDE H., Professor of Agricultural Engineering, Iowa State College, Ames, Iowa 1943
VAN WAMBECK, STANLEY H., Assistant Professor of Electrical Engineering, Washington University, St. Louis, Mo. 1938
VAN WERT, LELAND R., Chief, Metallurgical Division, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. 1941
VAN WINKLE, EDWARD H., Professor of Business Administration, Rensselaer Polytechnic Institute, Troy, N. Y. 1935
VARTERESSIAN, KEGHAM A., Instructor in Physics, The Pennsylvania State College, State College, Pa. 1943
VAUGH, MASON, Head of Agricultural Engineering, Allahabad Agricultural Institute, Allahabad, U.P., India 1944
VAUGHAN, JOSEPH L., Associate Professor and Head, School of English, University of Virginia, University, Va. 1930
VAUGHAN, L. L., Professor and Head, Dept. of Mechanical Engineering, Acting Dean, North Carolina State College, Raleigh, N. C. 1912
VAUGHN, KENNETH W., Executive Secretary, Measurement and Guidance Project in Engineering Education, S.P.E.E., E.C.P.D. and Carnegie Foundation for the Advancement of Teaching, 437 W. 59th St., New York, 19, N. Y. 1943
VAWTER, JAMISON, Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1926
VEAL, C. B., Manager, Coördinating Research Council, 30 Rockefeller Plaza, New York City 1910

VEIT, ROBERT C., Assistant Professor of Civil Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1939
VELZ, CLARENCE J., Professor of Sanitary Engineering, Head, Dept. of Civil Engineering, Manhattan College, New York City 1938
VENEGAS RUIZ, VALENTIN, Director, Escuela Superior de Ingenieria Mecania, Universidad Nacional Autonoma de Mexico, Mexico, D. F., Mexico 1943
VENN, ROLLO E., Assistant Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. **In military service** 1940
VENNARD, JOHN K., Assistant Professor of Fluid Mechanics, New York University, New York City 1935
VERPLANCK, DENNISTOUN W., Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. (Naval Ord. Lab., Washington, D. C.) 1937
VEZEAU, WALDO A., Assistant Professor of Mathematics, University of Detroit, Detroit, Mich. 1944
VIDOSIC, JOSEPH P., Assistant Professor of Engineering Drawing and Mechanics, Georgia School of Technology, Atlanta, Ga. **In military service** 1938
VIERCK, CHARLES J., Assistant Professor of Engineering Mechanics, The Pennsylvania State College, State College, Pa. 1942
VIERCK, ROBERT K., Assistant Professor of Engineering Mechanics, The Pennsylvania State College, State College, Pa. 1937
VILBRANDT, FRANK C., Professor and Head, Dept. of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. (*Member of Council 1944-47.*) 1931
VILLEMONTE, JAMES R., Assistant Professor of Civil Engineering, The Pennsylvania State College, State College, Pa. **In military service** 1941
VINCENT, EDWARD T., Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1940
VISSAT, PETER L., Research Engineer and Physicist, Tube Turns, Louisville, Ky. 1943
VITTUCCI, ROCCO V., Marine Engineer, Bureau of Ships, U. S. Navy Dept., Washington, D. C. 1938
VIVELL, ALLEN E., Acting Associate Professor and Acting Chairman, Dept. of Electrical Engineering, Swarthmore College, Swarthmore, Pa. 1937
VIVIAN, ROBERT E., Dean of Engineering, University of Southern California, Los Angeles, Calif. 1937
VON ESCHEN, GARVIN L., Associate Professor of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn. 1944
VON UREF, HARRISON A., Chief Bibliographer, Engineering Societies Library, 29 West 39th St., New York City 1942
VOORHIES, M. B., Professor of Electrical Engineering, Assistant to the Dean, Louisiana State University, University, La. 1935
VOPAT, WM. A., Assistant Professor of Mechanical Engineering, Cooper Union, New York City 1932
VOSE, F. H., Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, O. 1907
VOSS, WALTER C., Professor and Head of Building Construction, Massachusetts Institute of Technology, Cambridge, Mass. 1932
WABNITZ, W. S., Assistant Professor of English, University of Cincinnati, Cincinnati, Ohio 1932
WADE, FRANK H., Assistant Professor of Mechanics, Illinois Institute of Technology, Chicago, Ill. 1927

Wagner, Edward F., Instructor in Chemistry, Illinois Institute of Technology, Chicago, Ill. 1942

Wagner, Herman A., Consulting Mining and Metallurgical Engineer, 8 So. Michigan Ave., Chicago, 3, Ill. 1907

Wagner, Warren O., Manager, Duntan-Wagner Lumber Co., Keller, Wash. 1939

Waidelich, Donald L., Assistant Professor of Electrical Engineering, University of Missouri, Columbia, Mo. 1939

Wales, Royal L., Dean of Engineering, Rhode Island State College, Kingston, R. I. 1914

Walker, Andrew J., Professor of English, Georgia School of Technology, Atlanta, Ga. 1944

Walker, Charles A., Instructor in Chemical Engineering, Yale University, New Haven, Conn. 1942

Walker, Chas. L., Professor of Sanitary Engineering, College of Engineering, Cornell University, Ithaca, N. Y. 1910

Walker, Eric A., Associate Director, Underwater Sound Laboratory, Harvard University, Cambridge, Mass. 1938

Walker, Harry B., Professor of Agricultural Engineering, University of California, University Farm, Davis, Calif. (*Member of Council, 1935–36.*) 1921

Walker, Harold L., Professor and Head, Dept. of Mining and Metallurgical Engineering, University of Illinois, Urbana, Ill. 1943

Walker, Harry N., Director of Research, The B. G. Corp., New York City 1931

Walker, Leonard D., Assistant Professor of General Engineering Drawing, University of Illinois, Urbana, Ill. 1928

Walker, S. Branch, Capt. C.W.S., T-159, Huntsville Arsenal, Ala. In military service 1936

Walkup, Joseph K., Professor and Head, Dept. General Engineering, Iowa State College, Ames, Iowa 1941

Wall, Claude H., Associate Professor of Civil Engineering, The Ohio State University, Columbus, Ohio 1943

Wallace, John R., Instructor in General Engineering, University of Washington, Seattle, Wash. 1943

Wallace, Lawrence W., Vice President, Trundle Engineering Co., Cleveland, Ohio 1924

Wallis, Clifford M., Associate Professor of Electrical Engineering, University of Missouri, Columbia, Mo. In military service 1935

Walls, John A., President, Pennsylvania Water & Power Co., 1611 Lexington Bldg., Baltimore, Md. 1932

Walsh, Charles J., Supervisor of Engineering Drawing, Harvard University, Cambridge, Mass. 1944

Walsh, Frank W., Walsh's Visual Aids Co., 39 No. Delaplaine Rd., Riverside, Ill. 1928

Walsh, Harold V., Assistant Professor of Drafting, College of the City of New York, New York City 1940

Walter, Harold E., Professor of Mechanical Engineering, Newark College of Engineering, Newark, N. J. 1936

Walters, Jack E., Principal, McKinsey & Co., 60 E. 42nd St., New York City 1926

Walters, Raymond, President, University of Cincinnati, Cincinnati, Ohio 1935

Walther, Carl H., Associate Professor of Civil Engineering, George Washington University, Washington, D. C. 1942

WALTON, T. O., President, A. & M. College of Texas, College Station, Texas 1937

WANDMACHER, CORNELIUS, Assistant Professor of Civil Engineering, Director, Evening Session, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1939

WARD, HENRY T., Associate Professor of Chemical Engineering, Drexel Institute of Technology, Philadelphia, Pa. 1937

WARD, ROBERT P., Associate Professor of Electrical Engineering, A. & M. College of Texas, College Station, Texas 1937

WARD, SAMUEL, Professor and Head, Dept. of Mechanics and Materials, Fenn College, Cleveland, O. 1917

WARDELL, ARTHUR, Associate Professor of Engineering Drawing, University of Toronto, Toronto, Canada 1944

WARE, LAWRENCE A., Associate Professor of Electrical Engineering, State University of Iowa, Iowa City, Iowa 1939

WAREING, JOHN F., Lt. Comdr. U. S. N. R., Assistant Shop Supt., Training Officer, Philadelphia, Pa. **In military service** 1939

WARFIELD, CALVIN N., Senior Physicist, Flight Research Loads, NACA, Langley Field, Va. 1943

WARNER, FRANK M., Professor of Engineering Drawing, University of Washington, Seattle, Wash. 1927

WARNER, HARRY O., Professor and Head, Dept. of Electrical Engineering, University of Detroit, Detroit, Mich. 1926

WARNER, ROBERT W., Professor of Electrical Engineering, University of Texas, Austin, Texas 1930

WARNER, RUSSELL G., Chief Engineer, United Illuminating Co., New Haven, Conn. 1924

WARNOCK, WALTER G., Associate Professor of Mathematics, University of Alabama, Tuscaloosa, Ala. 1936

WARREN, A. JOLL, Instructor in Mechanical Engineering, Brown University, Providence, R. I. **In military service** 1941

WARREN, S. REID, Associate Professor of Electrical Engineering, University of Pennsylvania, Phialdelphia, Pa. 1943

WARRINGTON, HOWARD M., Assistant Vice President, Prentice Hall, Inc., 10 Brookland, Bronxville, N. Y. 1943

WASSON, HAROLD P., Assistant Professor of Mathematics, Newark College of Engineering, Newark, N. J. 1943

WATANABE, KENICHI, Instructor in Mathematics and Engineering, University of Hawaii, Honolulu, T. H. 1940

WATERFALL, HARRY W., Professor and Head, Dept. of Mechanical Engineering, Louisiana State University, University, La. 1937

WATERMAN, EARLE L., Professor and Head, Dept. of Civil Engineering, University of Iowa, Iowa City, Iowa *. 1923

WATERMAN, HERBERT, Associate Professor and Acting Head, Dept. of Chemical Engineering, University of Southern California, Los Angeles, Calif. 1941

WATERS, EVERETT O., Professor of Mechanical Engineering, Yale University, New Haven, Conn. 1914

WATERS, ERNEST W., Technical Employment Dept., Bell Telephone Labs., 463 West St., New York 14, N. Y. 1944

WATERS, JAMES S., Professor of Electrical Engineering, Rice Institute, Houston, Texas. **In military service** 1931

WATSON, ARTHUR E., Emeritus Associate Professor of Electrical Engineering, Brown University, Providence, R. I. 1924

WATSON, CLARENCE E., Assistant Professor of Industrial Relations, Northwestern University, Evanston, Ill. 1942
WATSON, HARRY D., Professor and Head, Dept. of Mechanical Engineering, University of Maine, Orono, Me. 1926
WATSON, HARRY J., Assistant Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. 1940
WATSON, HERBERT M., Radio Engineer, City of Richmond, 3622 Clinton Ave., Richmond, Calif. 1943
WATSON, JAMES W., Professor of Electrical Engineering, University of Wisconsin, Madison, Wis. 1910
WATSON, KENNETH M., Professor of Chemical Engineering, University of Wisconsin, Madison, Wis. 1943
WATSON, WALTER S., Associate Professor of Psychology, Director of Admissions and Student Relations, Cooper Union, New York City 1939
WATT, DAVID M., Head, Health, Safety and Service Dept., Proctor & Gamble Co., Ivorydale, Ohio 1940
WATTS, CALVIN T., Assistant Professor of Civil Engineering, Louisiana Polytechnic Institute, Ruston, La. 1941
WATWOOD, VERNON B., Professor of Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1941
WEAVER, FREDERIC N., Professor of Civil Engineering, Tufts College, Medford, Mass. 1924
WEBB, ALEXANDER R., Professor of Civil Engineering, Ohio Northern University, Ada, Ohio 1943
WEBB, EARL C., Extension Lecturer in Drawing, Purdue University; South Bend, Ind. 1937
WEBBER, H. A., Professor of Chemical Engineering, Iowa State College, Ames, Iowa 1939
WEBER, ANDREW R., Professor of Mechanical Engineering, University of Dayton, Dayton, Ohio 1935
WEBER, ERNST, Professor and Head, Dept. of Graduate Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1935
WEBER, HOMER S., Professor of Engineering Drawing and Mechanics, Georgia School of Technology, Atlanta, Ga. 1935
WEBER, PAUL, Professor of Chemical Engineering, Georgia School of Technology, Atlanta, Ga. 1944
WEBSTER, FRED N., Instructor in Mechanical Engineering, Tufts College, Medford, Mass. 1941
WEBSTER, JAMES C., Teacher, Armstrong High School, Washington, D. C. 1938
WEED, JOHN M., Associate Professor and Editor, Engineering Experiment Station, The Ohio State University, Columbus, Ohio 1923
WEEDEN, CLARENCE R., Instructor in Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. 1944
WEEDEN, HARMAR A., Instructor in Civil Engineering, Bucknell University, Lewisburg, Pa. **In military service** 1941
WEEMS, PHILIP V., Lt. Comdr. U. S. Navy, Randall House, Annapolis, Md. 1942
WEEMS, WILLIAM R., Assistant Commandant, Army Air Forces Engineering School, Wright Field, Dayton, Ohio 1944
WEIBEL, EMIL E., Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. 1936
WEIDLEIN, EDWARD R., Director, Mellon Institute of Industrial Research, Pittsburgh, Pa. 1936

WEIL, JOSEPH, Dean, College of Engineering, Director, Engineering Experiment Station, University of Florida, Gainesville, Fla. (*Member of Council, 1942–45*) 1923
WEIL, ROBERT T., Professor of Electrical Engineering, Manhattan College, New York City 1936
WEILAND, W. F., Associate Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. 1921
WEINBACH, M. P., Professor and Chairman, Dept. of Electrical Engineering, University of Missouri, Columbia, Mo. 1915
WEIR, JOHN J., Technical Writer, Sperry Gyroscope Co., 189 Hutton St., Jersey City, N. J. 1942
WEISER, HARRY B., Dean and Professor of Chemistry, Rice Institute, Houston, Texas 1938
WEISHAMPEL, JOHN A., Associate Professor of Mechanical Engineering, University of Alabama, University, Ala. 1943
WEISS, HERBERT A., Professor of Mechanical Engineering, Clarkson College of Technology, Potsdam, N. Y. 1930
WEISS, JOSEPH R., Instructor in Mechanical Engineering, College of the City of New York, New York City. **In military service** 1940
WELCH, ERNEST R., Associate Professor and Head, Dept. of Electrical Engineering, Howard University, Washington, D. C. **In military service** 1938
WELCH, FREDERIC W., Assistant Professor of Civil Engineering, State College of Washington, Pullman, Wash. 1921
WELCH, HERBERT E., Professor of Practical Science, Stockton Junior College, Stockton, Calif. 1942
WELLMAN, BERNARD L., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1937
WELLS, A. EDWIN, Assistant Professor of Engineering, Lowell Textile Institute, Melrose, Mass. 1943
WELLS, CORNELIUS A., Assistant Professor of Chemistry, Georgia School of Technology, Atlanta, Ga. 1944
WELLS, MELVILLE B., Professor Emeritus of Civil Engineering, Illinois Institute of Technology, Chicago, Ill. 1925
WELSH, FRANK H., Head, Div. Factory and General Education, International Business Machines Corp., Johnson City, N. Y. 1944
WENDT, KURT F., Associate Professor of Mechanics, University of Wisconsin, Madison, Wis. 1927
WENDT, ROBERT E., Instructor in General Engineering, Purdue University, Lafayette, Ind. 1922
WENDT, WYLIE B., Professor of Civil Engineering, Speed Scientific School, University of Louisville, Louisville, Ky. 1908
WERWATH, KARL O., Registrar, Milwaukee School of Engineering, Milwaukee, Wis. 1938
WESKE, JOHN R., Professor of Aerodynamics, Case School of Applied Science, Cleveland, Ohio 1937
WESSMAN, HAROLD E., Professor of Structural Engineering, Chairman, Dept. of Civil Engineering, New York University, New York City .. 1934
WESTERGAARD, HARALD M., Dean, Graduate School of Engineering; Gordon MacKay Professor of Civil Engineering, Harvard University, Cambridge, Mass. 1937
WESTFALL, ALFRED, Professor of English, Colorado State College, Fort Collins, Colo. 1944
WETZEL, IRWIN T., Lecturer in Mechanical Engineering, Northwestern University, Evanston, Ill. 1942

WEYSSER, JOHN L. G., Chief, Coal Section, Mining Div., W.P.B., Washington, D. C. 1940

WHEATON, HERBERT H., Staff Member, Radiation Lab., Massachusetts Institute of Technology, Cambridge, Mass. 1936

WHEELER, FRANK W., Associate Professor of Civil Engineering, University of Virginia, University, Va. 1943

WHELAN, DANIEL E., JR., Professor of Civil Engineering, Dean, College of Science, Loyola University, Los Angeles, Calif. 1931

WHENMAN, JOHN H., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. 1930

WHETSTONE, GEORGE A., Head, Dept. of Engineering, Amarillo College, Amarillo, Texas 1941

WHIPPLE, CLYDE C., Professor of Electrical Engineering, Brooklyn Polytechnic Institute, Brooklyn, N. Y. 1924

WHIPPLE, GEORGE F., Educational Director, Ponder Institute, 50 Beacon Street, Boston, Mass. 1937

WHIPPLE, WILLIAM, Professor of Steam Engineering, Louisiana State University, University, La. 1940

WHISLER, BENJAMIN A., Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa. **In military service** 1939

WHITAKER, MARTIN D., Assistant Professor and Acting Chairman, Dept. of Physics, New York University, New York City; 163 Outer Drive, Oak Ridge, Tenn. 1938

WHITE, ALBERT E., Director, Engineering Research, Professor of Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. .. 1941

WHITE, ALFRED H., Professor Emeritus of Chemical Engineering, University of Michigan, Ann Arbor, Mich. (*President, 1941–42; Member of Council, 1937–40; 1941–.*) 1920

WHITE, G. EDWIN, Assistant Professor of Chemical Engineering, College of the City of New York, New York City 1940

WHITE, HALL B., Assistant Professor of Agricultural Engineering, University of Minnesota, St. Paul, Minn. 1925

WHITE, HAROLD V., Professor and Head, Dept. of Metallurgy, Virginia Polytechnic Institute, Blacksburg, Va. 1937

WHITE, JOHN, Professor Retired, Rose Polytechnic Institute, 2235 No. 10 St., Terre Haute, Ind. 1929

WHITE, JOHN R., Instructor in Civil Engineering, College of the City of New York, New York City 1939

WHITE, KENNETH R., Instructor in Civil Engineering, University of Colorado, Boulder, Colo. 1942

WHITE, LEON V., Professor of Civil Engineering, Kansas State College, Manhattan, Kans. 1923

WHITE, MERIT P., Assistant Professor of Civil Engineering, Illinois Institute of Technology, Chicago, Ill. **In military service** 1941

WHITE, MYRA, Librarian, Northeastern University, Boston, Mass. 1941

WHITE, ROY A., Head, Engineering Dept., The Grand Rapids Junior College, Grand Rapids, Mich. 1925

WHITE, WALTER T., Research Engineer, Sperry Gyroscope Co., Inc., Great Neck, N. Y. 1939

WHITE, WILLIAM C., Dean of Engineering, Northeastern University, Boston, Mass. (*Member of Council, 1944–47.*) 1926

WHITFORD, DANIEL E., Assistant Professor of Mathematics, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1943

WHITFORD, ROBERT H., Physics-Chemistry Librarian, College of the City of New York, New York City 1942

WHITLEY, WYATT C., Associate Professor of Chemistry, Georgia School of Technology, Atlanta, Ga. 1944
WHITMER, ANNE B., Instructor in English, The Ohio State University, Columbus, Ohio 1942
WHITNEY, RICH D., Assistant Professor of Applied Mathematics, Syracuse University, Syracuse, N. Y. 1943
WHITSITT, WILLIAM G., Assistant Professor of Electrical Engineering, Vanderbilt University, Nashville, Tenn. 1944
WHITTEMORE, JOHN W., Professor and Head, Dept. of Ceramic Engineering, Associate Dean, Virginia Polytechnic Institute, Blacksburg, Va. 1937
WHITWELL, JOHN C., Associate Professor of Chemical Engineering, Princeton University, Princeton, N. J. 1936
WICKENDEN, WM. E., President, Case School of Applied Science, Cleveland, Ohio. (*President, 1933–34; Director of Investigations, 1923–29; Member of Council, 1924–7, 1933–.*) **Eighth Recipient, Lamme Medal (1935).** 1912
WICKERSHAM, ROBERT O., Senior Aeronautical Engineer, Wright Field, U.S.A.A.F., Materiel Command, Dayton, Ohio 1941
WIDDOP, ROBERT, Associate Professor of Industrial Engineering, Newark College of Engineering, Newark, N. J. 1932
WIDENER, BURTON M., Professor of Electrical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 1935
WIEDENHOEFER, EDGAR P., Associate Professor of Civil Engineering, Michigan College of M. & T., Houghton, Mich. 1944
WIGGINS, D. M., President, Texas College of M. & M., El Paso, Texas ... 1944
WILBUR, JOHN B., Professor and Acting Head, Dept. of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1934
WILBUR, RALPH S., Professor and Chairman, Dept. of Mechanical Engineering, Duke University, Durham, N. C. 1933
WILCOX, CARL C., Head, Dept. of Mechanical Engineering, University of Notre Dame, Notre Dame, Ind. 1939
WILCOX, DONALD B., Associate Professor of Industrial Engineering, University of Alabama, University, Ala. **In military service** 1937
WILCOX, ELGIN R., Professor and Head, Dept. of General Engineering, University of Washington, Seattle, Wash. (*Member of Council, 1933–6.*) 1925
WILCOX, HOWARD G., Dean, School of Mines, Professor of Geology and Mining, University of Alaska, College, Alaska 1940
WILCOX, JAMES E., Head, Dept. of Engineering, Santa Rosa Junior College, Santa Rosa, Calif. 1934
WILDES, KARL L., Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 1926
WILEY, CARROLL C., Professor of Civil Engineering, University of Illinois, Urbana, Ill. 1936
WILEY, RALPH B., Professor and Head, School of Civil Engineering, Director, Materials Testing Lab., Purdue University, Lafayette, Ind. (*Member of Council, 1938–41.*) 1920
WILEY, W. BRADFORD, Secretary, Manager, Educational Dept., John Wiley & Sons, Inc., 440 Fourth Ave., New York City 1937
WILEY, W. O., Publisher of Scientific Books, Chairman of the Board, John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. (*Treasurer, 1907–42.*) **Honorary member** 1904
WILHELM, ERNEST J., Associate Professor of Chemical Engineering, University of Notre Name, Notre Dame, Ind. 1939

WILHELM, RICHARD H., Associate Professor of Chemical Engineering, Princeton University, Princeton, N. J. 1936
WILKINSON, FORD L., Dean, Professor of Mechanical Engineering, Speed Scientific School, University of Louisville, Louisville, Ky. (*Member of Council, 1943–46.*) 1936
WILKINSON, GEORGE D., JR., Professor of Industrial Engineering, Newark College of Engineering, Newark, N. J. **In military service** 1935
WILKINSON, MEARLE W., Professor of Dental Materials and Metallurgy, University of Southern California, Santa Monica, Calif. 1943
WILKINSON, ROGER I., Member Technical Staff, Bell Telephone Labs., 463 West St., New York City 1936
WILL, ROY T., Supervisor, College Level Training, Consolidated Vultee Aircraft Corp., Fort Worth, Texas 1944
WILLARD, ARTHUR C., President, University of Illinois, Urbana, Ill. 1922
WILLEY, EARL C., Associate Professor of Mechanical Engineering, Oregon State College, Corvallis, Ore. 1929
WILLIAMS, BERT B., Assistant Professor of Civil Engineering, The Citadel, Charleston, S. C. 1939
WILLIAMS, CLEMENT C., Consultant, Engineering and Industrial Education, 129 Prospect St., Madison 5, Wis. (*Member of Council, 1920–3, 1935–; Vice President, 1928–9; President, 1931–5.*) 1909
WILLIAMS, EVERARD M., Senior Radio Engineer, Wright Field, Dayton, Ohio 1939
WILLIAMS, FRANK H. M., Associate Professor of Mathematics, Drexel Institute of Technology, Philadelphia, Pa. 1937
WILLIAMS, GEORGE K., Assistant Professor of Aeronautical Engineering, Georgia School of Technology, Atlanta, Ga. 1939
WILLIAMS, GORDON C., Associate Professor of Chemical Engineering, University of Louisville, Louisville, Ky. 1936
WILLIAMS, HAROLD I., Assistant Professor of Electrical Engineering, University of Vermont, Burlington, Vt. 1943
WILLIAMS, H. PAGE, Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1937
WILLIAMS, LA VERGNE E., Assistant Professor of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa. 1942
WILLIAMS, MARVIN O., Instructor in Aeronautical Engineering, Alabama Polytechnic Institute, Auburn, Ala. 1943
WILLIAMS, ROBERT S., Deputy Dean of Engineering, Head, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. 1943
WILLIAMS, REX Z., Associate Professor of Mechanics, Missouri School of Mines, Rolla, Mo. 1944
WILLIAMSON, JAMES H., 712 Warner Bldg., Nashville, Tenn. 1942
WILLIG, WALTER L., Assistant Professor of Civil Engineering, College of the City of New York, New York City 1937
WILLIGES, JOHN A., Associate Professor of Electrical Engineering, Heald Engineering College, 15 Crescent Ave., San Francisco, Calif. 1943
WILLIS, BEN S., Assistant Professor of Electrical Engineering, Iowa State College, Ames, Iowa 1929
WILLIS, CLODIUS H., Arthur Le Grand Doty Professor of Electrical Engineering, Princeton University, Princeton, N. J. (*Member of Council, 1933–36.*) 1936
WILLIS, PHILIP A., Senior Engineering Examiner, U. S. Civil Service Commission, 2912 Baker Drive, S.E., Washington, D. C. 1929
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WILLSON, F. G., Head, Department of Applied Electricity, Wentworth Institute, Boston, Mass. 1912
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WILSON, DAVID M., Professor of Civil Engineering, University of Southern California, Los Angeles, Calif. 1929
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WILSON, ERNEST D., Head, Dept. of Chemical Engineering and Chemistry, Worcester Polytechnic Institute, Worcester, Mass. 1940
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WILSON, WILBUR M., Research Professor of Structural Engineering, University of Illinois, Urbana, Ill. 1914
WILTSE, STANLEY B., Professor of Electrical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. 1935
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WINFREY, ROBLEY, Research Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa. In military service 1940
WING, ALEXANDER H., JR., Instructor in Electrical Engineering, College of the City of New York, New York City 1935
WINGREN, ROY M., Professor of Mechanical Engineering, Texas A. & M. College, College Station, Texas 1928
WINKLER, EDWIN W., Assistant Professor of Electrical Engineering, North Carolina State College, Raleigh, N. C. 1930
WINN, C. C., Dean of Engineering, Detroit Institute of Technology, Detroit, Mich. 1935
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WINTON, LOWELL S., Assistant Professor of Mathematics, North Carolina State College, Raleigh, N. C. 1939
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WISEMAN, EUGENE R., Associate Professor of Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y. 1940
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WISSMAN, ERNEST E., Manager, Plant Layout and Plant Methods, Douglas Aircraft Co., Inc., El Segundo, Calif. 1942
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WOOD, E. H., Professor of Mechanics of Engineering, Emeritus, Cornell University, Ithaca, N. Y. 1910
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Zelner, Otto S., Associate Professor of Surveying, University of Minnesota, Minneapolis, Minn. 1930
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Zimmer, Albert R., Professor of Electrical Engineering, University of Toronto, Toronto, Ont., Canada 1923
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Zozzora, Frank, Instructor in Graphics, Lafayette College, Easton, Pa. 1942
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Zweig, Felix, Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. 1943

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Hillis, Leonard F., Associate Professor of Civil and Structural Engineering, University of Wisconsin (Extension), Madison, Wis. 1945
Hintz, Carl W. E., Director of Libraries, University of Maryland, College Park, Md. 1945
Hutchinson, Robert O., Professor of Mathematics, Tennessee Polytechnic Institute, Cookeville, Tenn. 1945
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Schommer, J. J., *Industrial; Sanitary*
Schrenk, W. T., *Chemistry*
Schutz, P. W., *Min. Tech.*
Schuyler, W. H., *Chemistry*
Seely, J. F.
Sheerar, L. F., *Min. Tech.*
Sherman, G. W., *Physics*
Shires, L. B.
Shreve, R. N.
Simons, H. P.
Stout, L. E.
Sweeney, O. R.
Taylor, F. M.
Tiller, F. M.
Tour, R. S., *Mechanical*
Tully, T. J., *Chemistry*
Vilbrandt, F. C.
Walker, C. A.
Walker, S. B., *Mechanics*
Ward, H. T., *Chemistry*
Waterman, H., *Chemistry*
Watson, K. M., *Pet. & Nat. Gas*
Webber, H. A., *Heat Power*
Weber, Paul
White, A. H., *Metallurgy*
White, G. E.
White, John, *Chemistry*
Whitwell, J. C., *Textiles*
Wilhelm, E. J.
Wilhelm, R. H., *Chemistry*
Williams, G. C., *Metallurgy*
Wilson, E. D., *Chemistry*
Winding, C. C., *Chemistry*
Withrow, James R., *Mineral Tech.*
York, J. L., *Mineral Dressing*
Zimmerman, O. T.
Zur Burg, F. W.

CHEMISTRY

Arenson, S. B., *Chemical*
Backer, L. H., *Chemical*
Ball, T. R.
Barlow, Edward, *Chemical*
Bauder, F. W.
Baxter, R. A., *Chem.; Min. Tech.*
Bourgoin, L., *Economics*
Bradt, W. E., *Chemical*
Brais, R., *Chemical*
Brautlecht, C. A., *Chemical*
Disque, F. C., *Mathematics*
Durkee, F. W.
Ebaugh, W. C.
Edwards, H. L.
Fenton, C. L., *Electrical*
Freud, B. B., *Chemical; Physics*
Gibson, George, *Mining*
Gray, J. C.
Haenisch, E. L., *Chemical*
Hanson, R. S., *Chemical*
Joffe, Joseph, *Mathematics; Mechanics*
Kenny, F. J.
Komarewsky, V. T.
McCoy, J. E., *Chemical*
Neville, H. A., *Chemical Eng.*
Osterhof, G. G.
Phelps, R. T.
Riffenburg, H. B., *Chemical; Sanitary*
Russell, J. J.
Simard, J. M., *Min. Tech.*
Smith, O. M.
Spicer, W. M., *Physics*
Stewart, V. T., *Mathematics; Physics*
Strong, R. K., *Chemical*
Sunshine, I.
Supplee, L. F.
Swanton, W. F.
Swift, R. E., *Mineral Tech.*
Taylor, W. S.
Wagner, E. F.
Wasley, W. L.
Wells, C. A.
Whitley, W. C.
Wroth, B. B.

CIVIL ENGINEERING

Ackenheil, A. C., *Mech. & Mat.*
Adams, T. C., *Structural; Surveying*
Aikin, H. B., *Surveying; Mech. & Mat.*
Aldrich, M. H., *Surveying; Trans.*
Allan, William, *Hydraulics*
Allen, C. F., *Transportation*
Allen, Chester L., *Hydr., Mech. & Mat.*
Allen, C. M., *Hydraulics*
Allen, R. B., *Structural; Construction*

Allison, W. H., *Structural; Mech. & Mat.*
Almy, L. B., *Structural*
Anderegg, R. A.
Andersen, Paul, *Structural*
Anderson, John, *Surveying; Hydraulics*
Andreassen, A. T., *Mech. & Mat.*
Andrews, C. B., *Hydraulics*
Ashton, M. E., *Surveying*
Babcock, J. B., *Trans.; Constr.*
Bagley, J. W., *Mathematics*
Baker, W. H., *Mathematics*
Bakhmeteff, B. A.
Bantel, E. C. H., *Surveying; Sanitary*
Barclay, Leland
Barker, C. L., *Hydraulics*
Barnes, F. A., *Transportation; Constr.*
Barnes, G. E., *Hydraulics; Sanitary*
Barrows, H. K., *Hydraulics*
Bass, Frederic
Bauer, E. E., *Materials*
Bauer, J. V., *Arch. Eng.*
Bauwens, G. O., *Construction*
Becker, S. A., *Surveying; Eng. Drawing*
Begg, R. B. H.
Belz, C. J., *Surveying; Hydraulics*
Benford, W. R., *Hydraulics, Sanitary*
Benkert, H. N *Structural; Construction*
Bennett, E. F. *Soil Mech.*
Bennett, J. G.
Benson, F. J., *Structural*
Berg, H.
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Bird, J. M.
Bishop, C. T., *Structural; Construction*
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Black, R. P., *Surveying; Transportation*
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Blickenderfer, H.
Blodgett, H. B., *Mech. & Mat.*
Bogema, M., *Hydraulics*
Boguslavsky, B. W., *Structural; Mech.*
Bone, A. J., *Transportation*
Boon, L. F., *Surveying*
Borg, S. F., *Structural*
Borgquist, E. S., *Hydraulics; Sanitary*
Bouchard, Harry, *Surveying*
Bowler, E. W., *Hydraulics*
Bowman, H. L., *Structural; Mechanics*
Boyd, Alfred, *Structural; Hydraulics*
Bradshaw, G. W.
Bramer, C. R., *Hydr., Struc.*
Brater, E. F., *Hydraulics*
Breed, C. B., *Transportation*
Brinker, R. C., *Structural; Hydraulics*
Bromllow, F., *Eng. Dr.*
Brothers, L. A., *Structural; Surveying*
Brown, R. T., *Structural; Construction*
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Brust, A. W., *Mech. & Met.*
Bulger, J. W., *Structural; Mech. & Mat*
Burmister, D. M., *Soil Mech.*
Butler, J. B., *Transportation*
Camp, C. S., *Sanitary*
Carey, C. O., *Surveying*
Carlton, E. W., *Structural; Surveying*
Carpenter, S. T., *Struc.; Construction*
Carter, H. S.
Cartier, L., *Hydraulics*
Casagrande, Arthur, *Soils*
Castleman, F. L., *Struc.; Mech. & Mat.*
Caughey, R. A., *Structural; Mech. & Mat.*
Chaderton, J. C., *Construction*
Chamberlain, J. J., *Mech. & Mat.*
Chambers, A. L., *Struc.; Construction*
Clark, G. W., *Surveying; Hydraulics*
Clarke, E. L., *Sanitary*
Clement, W. B.
Clickener, C. K., *Mechanical*
Coddington, E. F., *Surveying*
Codwise, H. R., *Survey.; Transportation*
Collard, A. A., *Aero.*
Collier, I. L., *Surveying*
Comins, H. D., *Mechanics and Materials*
Compton, H. B., *Structural; Mech. & Mat.*
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Conley, H. G., *Struc.; Survey.*
Conrad, L. E., *Structural; Construction*
Constant, F. H.
Cook, R. M., *Mechanics*
Coolidge, W. A., *Structural*
Coopey, M. P., *Surveying*
Copeland, R. M., *Hydraulics*
Costa, J. J., *Structural*
Cottingham, W. S., *Structural; Mech. & Mat.*
Cox, G. N., *Hydraulics; Mech. & Mat.*
Crabtree, F. H., *Transportation; Constr.*
Crater, D. H., *Struc.; Survey.*
Crawford, I. C., Jr., *Sanitary*
Crawford, W. W., *Sanitary*
Cross, Hardy
Cunningham, C. W., *Structural*
Curtis, D. D., *Hydr.; Mech. & Mat.*
Cutler, A. S., *Surveying; Transportation*
Dake, E. D., *Structural; Constr.*
Daniels, W. T., *Mechanics*
Davidson, A. J., *Mech. & Met.*
Davis, C. V., *Economics*
Davis, H. E., *Structural; Mech. & Mat.*
Davis, R. E., *Structural; Mech. & Mat.*
Davis, R. P., *Structural*
Dawson, J. H., *Sanitary*
Dawson, R. F., *Soil Mech.*
Dean, G. T., *Aeronautics*
de Jong, S. H., *Surveying*
Dell, G. H., *Structural; Surveying*
DeMoyer, Robert, *Struc.; Mech. & Mat.*
Derleth, Chas., *Structural*
Diefendorf, A., *Transportation; Constr.*
Dodds, J. S., *Surveying*
Dodge, E. R., *Hydraulics*
Doll, Theodore, *Structural; Construction*
Doty, L. D., *Hydraulics; Economics*
Douglas, M. S., *Structural; Surveying*
Downing, R. L., *Hydraulics; Sanitary*
Downs, W. S., *Trans.*
Drager, F. E., *Surveying*
Duke, C. M., *Struc. Survey.*
Dunham, C. W., *Structural*
Dunlop, J. A., *Surveying*
Dunn, C. A., *Structural*
Dye, E. R.
Earnest, G. B., *Sur.; Hyd.*
Edgecomb, R. E., *Surveying*
Edwards, F. W., *Hydraulics*
Eichler, J. O., *Mech. & Mat.*
Elbin, G. H., *Structural; Mech. & Mat.*
Ellis, C. A., *Structural; Mathematics*
Ely, J. A., *Transportation*
Emmons, W. J., *Construction*
Eney, W. J., *Structural; Eng. Drawing*
Engle, E. D., *Surveying; Eng. Drawing*
Eubanks, I. S.
Evans, F. J., *Struc. & Constr.*
Evans, W. S., *Structural*
Evinger, M. I., *Sanitary*
Fadum, R. E., *Soil Mech.*
Faircloth, J. M., *Sanitary*
Farnham, C. S., *Surveying*
Feodoroff, N. V., *Struc.; Hydr.*
Ferguson, P. M., *Structural; Construction*
Finch, S. P.
Flinsch, H. V.
Flynn, E. C., *Structural; Survey.*
Focht, J. A., *Surveying*
Folk, J. T., *Des. Geom.*
Foote, F. S., *Railroad*
Foss, R. J., *Mechanics*

Fox, F. H., *Surveying; Transportation*
Fox, R. M., *Structural; Transportation*
Frazier, F. F., *Transportation*
Freel, W. I., *Hydraulics*
French, A. W., *Structural*
Friedrich, L., *Structural, Survey.*
Frost, D. C., *Surveying*
Fuller, A. H., *Structural*
Gallen, J. J., *Mathematics*
Gallogly, H. P., *Surveying*
Gant, E. V., *Mechanics*
Gardner, R. A.
Garner, C. L., *Structural; Survey.*
Garrelts, J. M., *Structural; Mech. & Mat.*
Gaylord, C. N., *Structural; Mech. & Mat.*
Gaylord, E. H., *Structural; Mech. & Met.*
Gehrig, A. G., *Structural*
Geyer, J. C.
Gifft, H. M., *Sanitary*
Giles, R. V., *Hydraulics; Sanitary*
Gillan, G. K., *Structural; Mech. & Met.*
Glenn, H. E., *Mech. & Mat.*
Glenn, W. D.
Gonzalez, O. Q.
Gram, L. M., *Structural; Construction*
Gramstorff, E. A., *Struc.; Mech. & Mat.*
Granger, A. T., *Struc.; Mech. & Mat.*
Grasso, S., *Hydraulics*
Graves, Q. B., *Sanitary*
Gray, H., *Mathematics*
Green, R. M., *Mechanics*
Greve, F. W., *Hydraulics*
Griffith, D. M., *Structural*
Griset, H. E., *Structural*
Guernsey, R., *Structural*
Gunder, D. F., *Mech. & Mat.*
Haertlein, Albert, *Structural; Surveying*
Haines, D. D., *Agricultural*
Hanrahan, F. J., *Structural; Constr.*
Hanson, T. C., *Hydraulics*
Harding, G. H., *Surveying*
Hargis, A. B., *Sanitary*
Harkness, D. H., *Surveying; Trans.*
Harlow, H. G., *Mechanics*
Harris, E. C., *Struc. Hydr.*
Hartman, Paul
Hatch, W. E., *Surveying*
Hathaway, A. S., *Surveying; Sanitary*
Haynes, H. G., *Engineering Drawing*
Helwig, C. E., *Mechanics*
Henderson, J. M., *Mech. & Mat.*
Hendrick, T. K. A., *Struc.; Hydraulics*
Hennes, R. G., *Mech. & Mat.*
Hiltner, W. F., *Hydraulics; Heat Power*
Hoadley, Anthony, *Structural*
Hoffman, O., *Mech. & Mat.*
Holmberg, C. H.
Holmes, F. E., *Surveying; Hydraulics*
Holt, A. H., *Surveying; Structural*
Honour, W. M., *Mech. & Mat.*
Hooper, W. T.
Horan, F. W., *Structural; Sanitary*
Housel, W. S., *Structural; Mech. & Mat.*
Howe, J. W., *Hydraulics*
Hubler, J. W., *Mech. & Mat.*
Hume, Wm., *Drawing; Mech. & Mat.*
Hummel, R. L., *Architecture*
Huntington, W. C., *Mech. & Mat.*
Huntley, P. C., *Mech. & Mat.*
Hurtubise, J. E., *Mech. & Mat.*
Hutchins, R. E., *Hydraulics*
Hutchison, A. W., *Hydraul; Mech. & Mat.*
Ippen, A. T., *Mechanics*
Jackson, N. E.
Jacobs, R. K., *Mechanics*
Jacoby, H. S., *Structural*
Jakkula, A. A., *Structural; Mech. & Mat.*
Jameyson, B., *Struc.; Trans.*
Jamieson, R. E., *Struc.; Mech. & Mat.*
Janssen, A. S., *Structural; Mech. & Mat.*
Jennings, R. T., *Struc.; Survey.*
Jensen, C. D., *Structural; Surveying*
Johnson, A. M., *Mechanics*
Johnson, A. R., *Structural*
Johnson, E. E., *Mechanics*
Johnson, R. C., *Hydraulics; Structural*
Jones, D. K.
Joseph, Bro. A., *Sanitary*
Kalinske, A. A., *Hydraulics; Mech. & Mat.*
Kampmeier, R. A., *Hydraulics*
Keith, G. M., *Drawing*
Keith, W. G., *Struc.; Survey.*
Kelly, J. W., *Mech. & Mat.*
Kemmer, L. H., *Surveying*
Kennard, H. J.
Kepner, H. R., *Structural; Mech. & Mat.*
Kerekes, Frank, *Structural*
Kesler, M. S.
Kesner, H. J., *Structural; Hydraulics*
Ketchum, M. S., *Structural*
Key, J. C.
Kiernan, C. J.
Kimball, W. P., *Construction*
Kindig, C. H., *Structural*
King, E. E., *Railway*
King, R.
Kinney, J. S., *Sanitary*
Kissam, Philip, *Survey.; Transportation*
Kittredge, R. B., *Transportation; Survey.*
Kleinschmidt, R. B., *Mathematics*
Knight, A. J., *Structural; Surveying*
Kozlowski, E., *Mech. & Mat.*
Krefeld, W. J., *Structural; Mech. & Mat.*
Krefeld, W. J., *Structural; Construction*
Krynine, D., *Structural*
Lagaard, M. B., *Drawing*
Lambert, B. J., *Structural; Construction*
Landon, R. D., *Hydraulics; Mech. & Mat.*
Lane, E. W., *Hydraulics*
Large, G. E., *Mech. & Mat.*
LaRue, H. A., *Surveying*
Latimer, C. A., *Draw.; Math.*
Lefavour, R. W., *Survey.; Mech. & Mat.*
Legault, A. R.
Legget, R. F., *Mechanics*
Leister, J. S., *Transportation*
Lendall, H. N., *Hydraulics; Sanitary*
Lenz, A. T., *Hydraulics*
Leonard, S. J., *Surveying; Hydraulics*
Lerner, S., *Struc., Sur.*
Lewis, R. L., *Mech. & Mat.*
Lindeman, M. F., *Structural*
Littleton, E. F., *Structural; Mech. & Mat.*
Lohr, W. S., *Structural; Mech. & Mat.*
Lommel, G. E., *Surveying*
Longwell, W. F. M., *Mechanics*
Looney, C. T. G., *Struc.; Mech. & Mat.*
Lowe, T. M., *Hydraulics; Sanitary*
Luther, H. B.
MacLean, E. A., *Structural; Mech. & Mat.*
Mains, L. P., *Structural; Mech. & Mat.*
Mains, R. M., *Mechanics*
Male, C. T., *Agricultural*
Maney, G. A., *Structural; Mech. & Mat.*
Mann, C. L., *Structural*
Marshall, O. J., *Surveying, Geodesy*
Marston, G. A., *Surveying; Hydraulics*
Martin, F. L., *Physics*
Matson, R. C.
Matzke, A. E.
Maugh, L. C., *Mech. & Mat.*
Mavis, F. T., *Hydraulics; Structural*
McCain, D. M., *Structural; Economics*
McCandliss, L. C., *Surveying; Hydraulics*
McCarthy, J. A., *Hydraulics*
McCaskey, A. E., *General*
McCullough, F. M., *Struc.; Mech. & Mat.*
McFarlan, H. J., *Surveying*
McFarland, R. A., *Surveying*

McGaw, A. J.
McLaurin, Banks, *Mech. & Mat.*
McNair, A. J., *Surveying; Mech. & Mat.*
McNew, J. T. L., *Economics*
McNown, W. C., *Highway*
McRee, F. L., *Transportation*
Mead, D. W., *Hydraulics*
Menoher, W. L., *Mechanics*
Merryfield, Fred, *Hydraulics; Sanitary*
Meyer, C. F., *Surveying; Sanitary*
Mickey, C. E., *Mech. & Mat.*
Middleton, E. V.
Miles, H. J., *Shop*
Miller, A. L., *Structural; Mech. & Mat.*
Miller, C. A., *Structural; Hydraulics*
Minnich, J. H., *Mech. & Mat.*
Minshall, R. E., *Structural; Construction*
Mirabelli, Eugene, *Struc.; Aeronautics*
Mirgain, F. C., *Surveying, hydraulics*
Mitchell, F. E.
Mitsch, J. D., *Struc., Survey.*
Mockmore, C. A., *Hydraulics*
Montz, J. M., *Survey.: Trans.*
Moody, H. W., *Physics*
Moore, E. B., *Structural; Mech. & Mat.*
More, C. C., *Structural*
Morris, C. T., *Structural; Mech. & Mat.*
Morris, F. C., *Survey.; Trans.*
Morris, H. M., *Structural*
Morrison, R. L., *Transportation*
Morse, R. F., *Structural; Surveying*
Mortland, J. A., *Architecture*
Mota, C. C., *Struc.; Surveying*
Moyer, R. A., *Transportation*
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Munoz, A. A.
Munson, T. A., *Hydraulics; Sanitary*
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Murdough, J. H., *Structural*
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Mylrea, T. D., *Structural; Mech. & Mat.*
Nagel, R. H., *Mechanics*
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Newton, Dudley, *Structural; Surveying*
Nikirk, F. A., *Economics*
Nilmeier, H. P.
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O'Connell, D. J., *Mech. & Mat.*
Oleson, C. C., *Mechanics and Materials*
Olitt, A.
Oliver, W. A., *Structural; Mech. & Mat.*
Olsen, G. A.
Ondra, O., *Drawing*
Opdyke, J. B., *Construction; Drawing*
O'Rourke, C. E., *Structures*
Orr, J. A.
Osborn, J. R., *Surveying*
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Park, J. C., *Surveying; Transportation*
Parkhill, G. W., *Surveying; Hydraulics*
Patten, W. E., *Hydraulics*
Paustian, R. G., *Survey.; Transportation*
Pearce, F. W., *Surveying; Mathematics*
Peck, G. V.
Penn, J. C., *Surveying*
Perez, Lawrence, *Hyd.; Mech. & Mat.*
Perry, J. E., *Transportation*
Person, H. T., *Mech. & Mat.*
Petty, B. H., *Transportation*
Pickels, G. W., *Hydraulics*
Plummer, F. L., *Struc.; Architectural*
Polkinghorne, W. C., *Struc.; Constr.*
Pope, L. C., *Structural; Transportation*
Posey, C. J., *Structural; Hydraulics*
Praeger, Emil
Prentice, T. H.
Prior, John, *Sanitary*
Puffer, L. B., *Hydraulics; Sanitary*
Pugsley, A. L., *Structural*
Pulver, H. E., *Structural; Mech. & Mat.*
Rader, L. F., *Transportation; Constr.*
Raeder, Warren, *Structural*
Ramberg, E. G. F., *Mech. & Mat.*
Rathbun, J. C., *Mech. & Mat.*
Rayner, W. H., *Surveying*
Reed, P. L., *Structural; Surveying*
Reese, R. C., *Structural; Architectural*
Reid, G. W., *Sanitary*
Reyhner, T. O., *Mechanics*
Reynolds, K. C., *Hydraulics*
Rhodes, F. H., *Structural*
Rhodes, L. S., *Surveying; Hydraulics*
Rice, P. P., *Surveying; Transportation*
Richmond, A. E., *Structural; Surveying*
Riedesel, G. A., *Surv., Constr.*
Rizzi, A. V., *Surveying*
Robbins, A. G.
Robbins, J. M., *Sanitary*
Rockwell, E. H., *Struc.; Mech. & Mat.*
Roehrig, G. F., *Structural; Mech. & Mat.*
Rogers, F. C.
Rogers, Paul, *Drawing*
Roos, P. K., *Surveying*
Rose, F. O., *Drawing; Mech. and Mat.*
Rose, F. W., *Surveying*
Rose, W. A., *Structural; Mech. & Mat.*
Rubey, Harry, *Survey.; Transportation*
Ruhl, R. C., *Mechanics*
Russell, F. A., *Transportation; Constr.*
Rutledge, P. C., *Mech. & Mat.*
Rutter, M. L.
Ryckman, S. J., *Sanitary*
Ryon, L. B., *Structural*
Sadler, W. C., *Transportation*
Sandstedt, C. E., *Structural*
Santry, I. W.
Schaffner, C. E., *Sanitary*
Schmidt, M. O., *Mechanics*
Schoder, E. W., *Hydraulics; Constr.*
Scofield, H. H., *Testing Mat.*
Scofield, W. F., *Struc.; Hyd.*
Scott, E. O., *Mechanics*
Sergev, S. I., *Mechanics*
Shank, J. R., *Structural*
Shanley, F. R.
Sharp, H. O., *Surveying; Transportation*
Shaver, R. E., *Survey.; Trans.*
Shaw, G. R., *Survey., Trans.*
Shedd, T. C., *Structural*
Sheiry, E. S., *Structural*
Sherlock, R. H., *Structural; Constr.*
Shilts, W. L., *Structural*
Shine, B. J., *Sanitary*
Short, W. I., *Surveying; Drawing*
Shuman, E. C., *Mech. & Mat.*
Silverman, J. R., *Structural*
Simpson, W. M., *Structural*
Sims, C. E., *Architecture*
Sims, J. R., *Drawing*
Skelton, R. R., *Struc., Trans., Constr.*
Sloane, R. L., *Mechanics*
Smith, Alva L.
Smith, G. I., *Sanitary*
Smith, T. D.
Smith, W. S., *Surveying; Eng. Dr.*
Snader, D. L., *Struc.; Hydr.*
Snyder, M. K., *Structural; Sanitary*
Sollenberger, N. J., *Mechanics*
Spears, S. M., *Structural; Surveying*
Speiden, H. W., *Hydraulics; Sanitary*
Spencer, E. L.
Spencer, W. R., *Surveying*
Springer, G. P., *Trans.; Surveying*
Spry, F. J., *Surveying*
Squire, E. J., *Structural*

Staley, H. R., *Bldg. Constr.*
Stanley, R. L.
Steinman, D. B., *Struc.; Architectural*
Stevens, R. L., *Struc.; Transportation*
Stewart, L. O., *Survey.; Transportation*
Stocking, E. J., *Personnel*
Straub, L. G., *Structural; Hydraulics*
Streeter, V. L., *Mech. & Mat.*
Stubbs, F. W., *Structural; Construction*
Sutherland, Hale, *Structural*
Swanson, H. A., *Struc., Survey.*
Sweetser, E. O., *Structural; Construction*
T'ang, C., *Struc., Hydraulics*
Tate, M. B.
Taylor, A. D., *Mech. & Mat.*
Taylor, D. W., *Soil Mechanics*
Taylor, F. M., *Surveying*
Taylor, K. V., *Struc.; Constr.*
Taylor, W. C., *Surveying: Sanitary*
Thatcher, R. Y., *Trans.; Economics*
Theroux, F. R., *Sanitary*
Thoman, W. H., *Mech. & Mat.*
Thomas, F.
Thomas, H. A., *Hydraulics; Sanitary*
Thompson, H. L., *Sanitary*
Thompson, J. N., *Mechanics*
Thompson, J. T., *Struc., Trans.*
Thompson, Sophus, *Struc.; Mech. & Mat*
Timby, E. K., *Struc., Constr.*
Tippy, K. C., *Hydraulics*
Todd, M. W., *Surveying*
Tomlinson, G. E., *Construction*
Townsend, E. J.
Tracy, J. C.
Trively, I. A., *Mechanics*
Trowbridge, D. S., *Survey.; Mech. & Mat.*
Troxwell, G. F., *Mech. & Mat.*
Tschebotarioff, G. P., *Soil Mech.*
Turner, A. S.
Twogood, A. J., *Surveying; Physics*
Uhler, E. H., *Structural; Mech. & Mat.*
Underwood, P. H., *Surveying; Math.*
Van Buren, M. H., *Struc.; Mech. & Mat*
Van den Broek, J. A., *Struc.; Mech. & Mat.*
Van Hagan, L. F., *Economics*
Vawter, J., *Structural*
Veit, R. C., *Structural*
Velz, C. J., *Sanitary*
Villemonte, J. R., *Hydr., Constr.*
Wagner, W. O., *Hydraulics*
Walker, S. B., *Patents*
Wall, C. H., *Mathematics*
Walther, C. H., *Structural*
Wandmacher, C., *Structural*
Watts, C. T., *Drawing*
Watwood, V. B.
Weaver, F. N., *Mech. & Mat.*
Webb, A. R., *Sanitary*
Weeden, H. A., *Mech. & Mat.*
Welch, F. W., *Surveying*
Wells, M. B., *Structural; Aeronautics*
Wendt, W. B., *Construction*
Wessman, H. E., *Structural; Constr.*
Wheeler, F. W., *Mechanics*
Whisler, B. A., *Sanitary*
White, J. R., *Mech. & Mat.*
White, K. R.
White, L. V., *Surveying*
White, K. P., *Architectural Eng.*
White, M. P.
Wiedenhoefer, E. P.
Wilbur, J. B., *Structural*
Wiley, C. C., *Transportation*
Williams, B. B., *Drawing*
Williams, J. W.
Willig, W. L., *Surveying; Structural*
Wilsey, E. F.
Wilson, D. M., *Structural*
Wilson, F. C., *Sanitary*
Wilson, F. W., *Structural*
Wilson, W. M., *Structural; Mech. & Mat.*
Winfrey, R., *Valuation*
Winn, H. F., *Mech. & Mat.*
Winterkorn, H. F., *Soils*
Wiskocil, C. T., *Struc.; Hyd.*
Witmer, F. P., *Structural*
Wood, H. W., *Mech. & Mat.*
Woodburn, J. G., *Hydraulics*
Woods, K. B., *Highway*
Woodward, S. M., *Hydraulics*
Worley, J. S., *Transportation*
Wray, R. C., *Structural; Mech. & Mat.*
Wright, C. A., *Hydraulics; General*
Yasines, S. F., *Math.; Mech. & Mat.*
Young, D. H., *Mechanics*
Young, E., *Surveying*
Zelner, O. S., *Surveying*

ECONOMICS AND ENGINEERING ECONOMY

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Bowman, D. O.
Brown, J. C.
Brozen, Y., *Chemistry*
Cooley, H. B., *Civil, transportation*
Garrett, S. S., *Ind. Eng.*
Goetz, B. E., *Industrial*
Grant, E. L., *Civil; Industrial*
Harris, W. R., *General Eng.*
Hastings, H. B., *Industrial*
Johnson, S. F., *History*
Larkin, J. D., *Pol. Science*
Lindemann, A. J., *Industrial*
McKenry, Neil
Palmerton, L. R., *Eng.-Social Sci.*
Price, R. C., *Industrial*
Proctor, W. J., *Social Science*
Schwelger, A. J., *Government & Business*
Simon, H. A., *Political Science*
Simonds, R. H., *Industrial*
Spencer, M. W., *Industrial*
Spiegel, D. K., *Industrial*
Van Winkle, E. H.
Watson, W. S., *Psychology*
Wheaton, H. H., *Mathematics*
Wright, R. V., *Citizenship*

ELECTRICAL ENGINEERING

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Addison, G. T., *Coördinator*
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Albert, A. L., *Communication*
Alexander, D. C.
Alger, P. L., *Industrial Eng.*
Allinson, A. R., *Power; Communication*
Allured, R. B.
Anderson, C. A., *General*
Anderson, H. W., *Communication; Math.*
Andreae, S. C., *Power*
Andres, P. G., *Communication*
Angerman, W. G., *Power*
Armstrong, E. H., *Communication*
Archer, L. B.
Attwood, S. S., *Physics*
Ax, L. S., *Power; Physics*
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Bailey, B. F., *Power*
Bailey, R. E.
Balint, A. T.
Balsbaugh, J. C., *Power*
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Barnett, B.
Barrows, W. E., *Power; Illumination*
Barry, J. G., *Communication*

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Bennett, R. D., *Physics*
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Bliss, W. H., *Communication*
Boast, W. B., *Power Illum.*
Boone, E. M., *Comm.; Physics*
Bowles, E. L., *Communication; Indus.*
Bowman, J. H., *Power*
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Brenton, Walter
Bronwell, A. B., *Commun.*
Brooks, Morgan
Brown, A. S., *Power*
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Brown, Hugh, *Power, Comm.*
Brown, W. F., *General*
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Bueche, H. S.
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Caparo, J. A., *Mathematics*
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Carr, C. C., *Power*
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Charp, S., *Power; Comm.*
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Clements, S. E., *Communication*
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Conover, L. J.
Conrad, A. G., *Industrial Administrator*
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Credle, A. B., *Communication*
Creese, M., *Power*
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Dasher, B. J.
Davidson, G. A.
Dawes, C. L., *Power*
Dawes, L. M., *Power; Industrial*
Dawson, C. H., *Mech. & Mat.*
Dean, J. E., *Power*
Decker, F. A., *Mech. & Mat.*
Dennison, B. C., *Power*
Dickey, D. W.
Dillingham, H. C., *Communication*
Dixon, H. S., *Illumination*
Dixon, W. R., *Power*
Doggett, L. A., *Power*
Douglas, J. F. H., *Physics*
Dow, W. G., *Physics*
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Dunn, C. H.
DuVall, W. C., *Power*
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Essigmann, M. W., *Mathematics*
Evans, H. S.
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Guillemin, E. A., *Communication*
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Hamlin, E. W., *Communication*
Hanstein, H. B., *Power*
Harness, G. T., *Power*
Harris, L. D., *Power; Comm.*
Hart, S. V.
Hartig, H. E., *Communication*
Hatch, W. E., *Power*
Hattrup, H. E., *Power*
Haupt, L. M., *Power*
Hayward, H. N., *Power*
Hazen, H. L., *Power*
Heath, E. B., *Power*

Henderson, R. B., *Power*
Hess, H. M., *Power*
Hessler, V. P., *Power*
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Hill, A. St. J., *Power*
Hill, W. W.
Hirst, J. M., *Power*
Hoadley, G. B., *Mathematics; Physics*
Hodge, C. A., *Power*
Hodgins, L. J., *Power*
Holland, L. N., *Communication*
Hollister, V. L., *Power*
Holmes, L. C., *Power*
Holt, C. B., *Power; Mathematics*
Holtby, F.
Honnell, M. A., *Communication*
Hoover, P. L., *Power; Mathematics*
Horn, H. W., *Power; Illumination*
Houston, R. K., *Power; Comm.*
Hovey, R. K., *Power*
Howell, A. H., *Power*
Howes, D. E., *Communication*
Hudson, C. A., *Communication*
Hudson, P. K., *Physics*
Hughes, M. C., *Power*
Hull, R. H., *Power; Communication*
Hunt, O. D., *Illumination*
Irland, G. A., *Power; Communication*
Jackson, D. C., *Power*
Jackson, F. D., *Communication*
Janes, C. W., *Mechanical*
Jansky, C. M.
Jenkins, H. M., *Power*
Jenkins, J., *Power; Comm.*
Johnson, E. W., *Power; Illumination*
Johnson, J. H., *Power; Illumination*
Johnson, R. E., *Power*
Johnson, W. G., *Power; Comm.*
Jones, E. C., *Power*
Jones, E. W.
Jones, H. L., *Communications*
Jones, R. W., *Machine Design*
Jordan, H. G., *Power*
Jordan, Wm., *Physics*
Jorgenson, L. M., *Power; Physics*
Karr, J. H., *Power*
Kebernick, O. C., *Power; Math.*
Keener, C. A., *Power*
Keever, L. M.
Keith, G. M.
Kelso, L. E. A., *Power*
Kerchner, R. M., *Power*
Kimbark, E. W., *Power*
Kimberly, E. E., *Power*
King, Morland, *Communication*
Kingsley, C., *General*
Kinney, E. E., *Power*
Kinsloe, C. L., *Power*
Klein, G. W., *Drawing*
Kloeffler, R. G., *Communications*
Knight, A. R., *Power; Illumination*
Knipmeyer, C. C., *Power; Mechanical*
Koopman, R. J. W., *Power*
Kraehenbuehl, J. O., *Power Comm.*
Kraybill, E. K., *General*
Kuhlmann, J. H., *Power*
Kurtz, E. B., *Power; Illumination*
Laestadius, J. E., *Power; Physics*
Lake, R. E., *Communications*
Lamb, J. F., *Power*
Lange, E. O., *Power; Industrial*
Laning, W. A., *Communication*
Lansil, C. E., *Power*
La Pierre, W. A., *Power*
Larsen, M. J., *Communication*
Larson, L. C., *Power*
Laurence, J., *Mathematics*
Leblanc, F.
Lear, J. E., *Illumination*
Lee, Claudius, *Physics*
Lehman, L. G., *Power*
Levy, G. F., *Power*
Lewis, W. A., *Power*
Lickey, H. F., *Commun.; Illumination*
Lindvall, F. C., *Mechanical*
Lippitt, V. G., *Mathematics*
Liwschitz-Garik, M., *Power*
Locke, W. W., *Educational Administrator*
Lott, A. O., *Mechanical*
Lovell, W. E.
Lovett, I. H., *Power*
Lutz, S. G., *Power; Communication*
MacKavanagh, T. J., *Power*
MacKichon, K. B., *Power*
Marchant, G. B., *Eng. Drawing; Math.*
Mallory, D. D., *Power*
Manning, M. L., *Power*
Markle, E. W., *Power*
Mason, H. R., *Power*
Maxfield, H. A.
Maxwell, F. R., *Power; Aeronautics*
McClain, F. H., *Power*
McClinton, A. T., *Communication*
McClure, O. E., *Power; Physics*
McCrumm, J. D., *Power; Mathematics*
McEnany, M. V., *Physics*
McIlroy, M. S., *Power*
McIntyre, J. A.
McKee, E. R., *Power; Communication*
McMillan, F. O., *Power; Physics*
Meier, O., *Power; Illum.*
Michalowicz, J. C.
Miller, E. F., *Communications*
Miller, J. B., *Power*
Miller, W. J., *Power; Illumination*
Miliman, J.
Mills, G. H., *Power*
Miner, D. F., *Power*
Moench, H. A., *Communication*
Moore, A. D.
Morgan, M. G., *Physics*
Morgan, R. B., *Physics*
Morgan, T. H., *Power*
Morton, P. L., *Power*
Mueller, G. V., *Power*
Murray, W. A., *Communication*
Naeter, Albrecht, *Power*
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Nelson, P. H., *Power; Comm.*
Newell, H. H., *Communication*
Nichols, B. H., *Power*
Niessink, T.
Nims, A. A., *Power; Communication*
Norris, Bob
Norris, C. B., *Power; Communication*
Norris, F. W., *Communication*
Northcott, J. A., *Power*
Northrop, M. G., *Power; Comm.*
Nudd, Philip, *Power*
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Obonkhnoff, N. M., *Mathematics*
O'Brien, E. J., *Communication*
Oler, C. B., *Power*
Ordung, P. F.
Osborn, R. E.
Osborne, H. S., *Communication*
Osburn, O. E.
Paine, E. B., *Power*
Palmer, H. B., *Power*
Pearson, D. S., *Power; Physics*
Pease, E. M. J., *Mathematics*
Peet, J. C., *Power*
Peirce, G. R.
Perrone, S. A., *Communication*
Peterson, D. I., *Communication*
Peterson, E. F., *Power*
Pettit, J. M., *Physics*

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Pierce, C. A., *Mathematics*
Plowman, A. S.
Poole, F. L., *Power; Physics*
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Porter, R. G., *Communication*
Potter, J. L., *Communication*
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Powers, A. R., *Power*
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Price, H. W., *Power; Mechanical*
Price, J. R., *Power*
Puchstein, A. F., *Power; Mechanical*
Pullen, M. W., *Illumination*
Pumphrey, F. H., *Power*
Purnell, L. J.
Putnam, R. C., *Power; Illumination*
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Radford, W. H., *Communication*
Ramler, W. J.
Ray, B. M., *Power; Math.*
Record, F. A., *Physics*
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Reich, H. J., *Communication; Physics*
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Reintjes, J. F., *Communication*
Reukema, L. E., *Communication*
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Romanowitz, H. A., *Communication*
Rook, C. W., *Power*
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Rudenberg, R., *Physics*
Rush, H. S., *Aeronautics*
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Russell, F. A., *Mathematics*
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Sandorf, I. J., *Power; Communication*
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Satullo, A. R.
Saylor, W. R.
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Schumann, Fred
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Torgersen, H., *Power*
Towle, N. L., *Power*
Tracy, G. F., *Power*
Trueblood, R. O., *Mechanical*
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Turner, H. M., *Power; Communication*
Turner, R. C., *Power*
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Walker, H. N., *Power; Illumination*
Wallis, C. M., *Commun.; Illumination*
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Ware, L. A., *Power; Communication*
Wareing, J. F., *Power*
Warner, H. O., *Power*
Warner, R. G., *Power*
Warner, R. W., *Power*
Warren, S. R.
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Root, R. E., *Mechanics & Materials*
Rosenbach, J. B., *Physics*
Roth, S. G.
Runge, L. L., *Economics*
Schmidt, H. P., *Physics*
Seagraves, W. P., *Mech. & Mat.; Physics*
Sedgwick, C. H. W.
Simester, J. H.
Simmons, F. A., *Civil*
Small, L. L.
Smith, E. S., *Mechanics*
Smith, S. R., *Physics*
Solt, M. R.
Spacie, E. G., *Physics*
Sparks, F. W.
Spear, Joseph
Stipe, C. G., *Civil*
Strane, A. J., *Industrial; Mineral Tech*
Stratton, W. T., *Physics*
Straw, J. A., *Electrical*
Strobel, C. F.
Swanton, W. F., *Chemical*
Synge, J. L.
Temple, V. B.
Terrell, W. P., *Mechanics*
Thomas, C. F., *Civil, surveying*
Thomas, D. Boyd, *Physics*
Thomas, Evan, *Mechanical*
Torrance, C. C., *Physics*
Tudbury, C. W
Van Buskirk, H. C.
Vezeau, W. A.
Warnock, W. G.
Watanabe, K.
Whitford, D. E., *Mechanics*
Whitney, R. D., *Communications*
Williams, F. H. M.
Williams, H. P., *English; Psychology*
Winton, L. S.
Wray, J. W.
Yanosik, G. A., *Civil, structural*
Zant, J. H.
Zeldin, S. D.

MECHANICAL ENGINEERING

Aldrich, B. M., *Drawing; Math.*
Algren, A. B., *Refrigeration*
Allen, C. M., *Refrigeration*
Allen, F. E., *Metallurgy*
Allen, R. L., *Heat Power*
Almsted, F. E., *Naval*
Ambrosius, E. E., *Heat Power*
Amidon, L. L., *Mach. Des.; Heat Power*
Anderson, C. G.
Anderson, C. E., *Heat Power*
Anderson, C. O., *Heat Power*
Anderson, E., *Heat Power; Power Plants*
Andrews, D. K.
Anthony, R. L., *Heat Power; Industrial*
Arm, D. L., *Machine Design; Heat Power*
Arnold, J. E., *Aeronautics*
Aulich, W. M., *Mach. Des.; Econ.; Eng. Drawing*
Ault, E. S., *Machine Design; Mfg. Proc.*
Auth, G. H.
Ayers, M. T., *Machine Design*
Ayre, R. S., *Mech. & Mat.*
Bacon, R. A., *Machine Design*
Bagley, J. B., *Textile*
Bailey, J. F., *Mechanics*
Bailey, N. P., *Aeronautics*
Bailey, W. S., *General; Mech. & Mat.*
Baker, E. C., *Aeronautics*
Baker, H. D., *Physics*
Barber, W. J., *Mach. Design; Heat Power*
Barnard, N. H., *Industrial; Mfg. Proc.*
Baumeister, T., *Heat Power; Pr. Pls.*
Baylor, J. E., *Mfg. Proc., H-P.*
Beckwith, T. G.
Begeman, M. L., *Mach. Des.; Mfg. Proc.*
Beitler, S. R., *Heat Power*
Bell, N. R., *Electrical*
Benson, L. R., *Mfg. Proc.; Met.*
Berger, F. A., *Machine Des.*
Berry, C. H., *Heat Power; Power Plants*
Berryman, L. G., *Mineral Tech.*
Best, H. W.
Billmyer, C. D., *Machine Design; Indus.*
Binder, R. C., *Mech. & Mat.*
Birkness, H. A.
Bischof, G. J., *Metallurgy*
Black, P. H., *Mech. & Mat.*
Blackburn, H. W., *Heat Power*
Blaisdell, A. H., *Aeronautics*
Blumberg, L., *Machine Design; General*
Bock, A. E., *Power*
Bogard, B. T
Bolz, H. A., *Mach. Design; Mech. & Mat.*
Boston, O. W., *Mfg. Processes*
Bowman, H. T., *Heat Pr.; Mech. & Mat.*
Boyan, E. A.
Boynton, J. E., *Machine Design, Heat Pr.*
Brady, W. H., *Design; Surveying*
Bragg, F. C., *Drawing*
Brainard, B. B., *Heat Power; Min. Tech.*
Breckenridge, R. W., *Mfg. Proc.; Shop*
Brickler, A. J., *Mech. & Mat.*
Brown, A. I., *Heat, Refrigeration*
Brown, R. E., *Mathematics*
Brown, R. V., *Heat Power*
Brown, T. C., *Drawing*
Bucher, P., *Heat Power; Power Plants*
Buckingham, E., *Mach. Des.; Mfg. Proc.*
Budenholzer, R. A., *Heat Power*
Buerer, W., *Heat Power*
Burr, A. H., *Mech. & Mat.*
Butler, H. W., *Mechanics and Materials*
Butler, N. R.
Butterfield, T. E.
Calhoon, F. N., *Heat Power*
Cameron, Hugh S., *Heat Power*
Campbell, J. M., *Heat Power*
Campbell, W. B., *Mech. & Mat.*
Candee, F. W., *Heat Power*
Carmichael, Colin, *Machine Design*
Carpenter, E. L.
Carvin, F. D., *Heat Power; Refrigeration*
Casberg, C. H., *Mfg. Processes*
Case, A. A., *Shop*
Cather, H. M., *Heat Power; Power Pls.*

Caywood, T. G., *Mach. Des.; Mfg. Proc.*
Cejka, J. B., *Eng. Draw.; Mech. & Mat.*
Chamberlain, J. B., *Mfg. Proc.*
Chapman, R. G., *Mech. & Mat.*
Chase, C. H., *Mach. Des.; Power P.*
Cherry, F. H., *Mechanics; Eng. Drawing*
Christie, A. G., *Power Plants; General*
Church, A. H., *Machine Des.*
Church, E. F., *Aeronautics; Metallurgy*
Clark, D. S., *Mfg. Proc.; Met.*
Clark, R. E., *Heat Power*
Cleghorn, M. P., *Heat Power; Power Pls*
Clower, J. I., *Machine Design*
Colbert, T. P., *Machine Design*
Cole, R. W., *Drawing*
Collard, A. A., *Mechanics*
Coogan, C. H., *Heat Power*
Coonradt, A. C., *Aeronautics*
Cooper, L. B., *Mech. & Mat.*
Cope, R. L., *Industrial*
Cope, W. J., *Heat Power*
CoVan, J. P., *Mfg. Processes*
Cowie, Alexander, *Machine Design*
Crawford, C. W., *Indus.; Mech. & Mat.*
Crofoot, G. E., *Heat Power; Refrig.*
Croft, H. O., *Heat Power; Economics*
Cromer, O. C., *Heat Power*
Crowder, B. A., *Mfg. Processes*
Dale, R. B., *Math.*
Daugherty, R. L., *Hydraulics*
Davis, J. H., *Mechanics*
Davis, L. E., *Industrial*
Davis, S. S., *Heat Power*
Dawson, E. F., *Air Conditioning*
DeGarmo, E. P., *Heat Pr.; Indus.*
Degler, H. E., *Heat Power; Power Plants*
Dent, J. A., *Heat Power; Power Plants*
Devine, Jas. J., *Heat Power*
Devor, E. L., *Mach. Des.; Mfg. Proc.*
Diakoff, A. J., *Aeronautics*
Domonoske, A. B.
Donovan, E. T., *Heat Power; Power Pls.*
Doolittle, J. S., *Heat Power; Refrig.*
Doughtie, V. L., *Machine Design; Aeron*
Dowell, Dawson
Downs, J. B. T.
Dows, H. W., *Mfg. Processes; Shop*
Dray, R. C.
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Dunkin, W. V.
Dunlap, A. L., *Mechanics and Materials*
DuPriest, J. R., *Mach. Des.; Heat Power*
Durand, W. F.
Dusinberre, G. M., *Heat Power*
Eames, J. J., *Heat Power*
Easton, W. H.
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Ebaugh, N. C., *Heat Power*
Eckerman, E. H., *Drawing*
Eckhardt, C. J., *Heat Power; Refrig*
Edstrom, A. E.
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Emerson, W. D., *Heat Power; Power Pls.*
Endsley, L. E.
Ermenc, J. J., *Heat Power*
Estep, T. G., *Heat Power*
Espy, W. N., *Thermo.*
Evans, F. R.
Everett, H. A., *Heat Power*
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Fairfield, J. G., *Heat Power; Mach. Des.*
Falls, E. K., *Fluid Mechanics*
Fellows, J. R., *Heat Power; Civil*
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Fessenden, E. A., *Refrigeration*
Files, C. W.
Finlayson, F. S., *Aeronautics*
Finnegan, J. B., *Fire Protection*
Fisher, D. A., *Heat Power*
Fitch, W. C., *Economics*
Flanigan, A. E., *Mineral Tech.*
Fleming, D. W.
Flinner, A. O., *Heat Power; Power Pls*
Folsom, R. G., *Hydraulics*
Ford, A. D., *Aeronautics*
Fornes, G. G., *Machine design*
Forstall, W., *Industrial*
Foster, C. A. B., *Drawing*
Freberg, C. R., *Aeronautics*
Fry, H. P., *Drawing*
Fullan, M. T., *Mach. Des.; Eng. Drawing*
Fullerton, H. P., *Mech. & Mat.*
Gall, W. R., *Industrial*
Gallalee, J. M., *Heat Power; Power Pls.*
Garman, W. D., *Power Plants; Mechanics*
Gatcombe, E. K., *Machine Design*
Gatley, E. R.
Gauss, H. F., *Machine Design, Refrig.*
Geer, R. L., *Mfg. Proc.*
Geiger, J. W., *Heat Power*
George, V. C., *Mechanics*
Getchell, E. L., *Mechanics*
Giannini, M. C., *Heat Power*
Gibbs, R. E., *Heat Power; Power Plants*
Giesecke, F. E., *Heat Power*
Gilbert, W. W., *Aeronautics*
Gilpin, C. A., *Heat Power*
Gjesdahl, M. S., *Machine Design*
Gleason, J. G., *Aeronautics*
Godeke, H. F., *Mfg. Proc.; Heat Power*
Goglia, M. J., *Aeronautics*
Goode, H. P., *Eng. Drawing*
Goodman, W.
Gorman, W. M., *Shop and Mechanic Arts*
Grace, C. T., *Machine Design*
Graf, S. H., *Mech. & Mat.*
Gray, E. S., *Heat Power*
Gray, H. C., *Machine Design*
Gray, M. E., *Mfg. Proc.*
Green, B. M., *Machine Des.*
Green, W. A., *Heat Power*
Green, W. P., *Heat Power*
Greenwald, D. U., *Industrial*
Greenwood, E. J. A.
Greffe, C. D., *Aeronautics*
Greyson, J. C., *Mechanics*
Griffin, F. S., *Mach. Des.; Eng. Drawing*
Grosser, C. E., *Machine Design*
Grosser, W. R.
Guerdan, G. A., *Mach. Design; Mfg. Proc*
Gullikson, A. C., *Drawing*
Gurney, G. T.
Hall, A. S.
Hall, C. A., *Heat Power*
Hall, S. R., *Drawing; Shop*
Halliday, W. R., *Machine Design; Eng.*
Ham, C. W., *Machine Design; Mfg. Proc.*
Hamilton, E. H., *Heat Power; Shop*
Haney, J. W., *Heat Power; Power Plants*
Hanson, K. P., *Heat Power*
Hardgrave, J. C., *Mfg. Processes; Shop*
Harrington, R. L., *Industrial*
Hawkins, G. A., *Physics*
Hawley, R. S., *Industrial*
Hawn, H. W., *Refrig.; Mechanics*
Hay, E. D., *Industrial; Aeronautics*
Hays, F. B.
Hazen, J. W., *Heat Power; Refrigeration*
Heath, C. O., *H-P.; Metallurgy*
Helander, Linn, *Heat Power; Power Pls.*

Hem, L. W.
Henika, J. H., *Shop and Mechanic Arts*
Henry, G. F., *Dr.; Shop.*
Henry, J. A., *Heat Power*
Hetzel, T. B., *Eng. Drawing*
Hibbard, S. S., *Mechanics*
Hill, A. M., *Heat Power; Refrigeration*
Hinkle, R. T., *Machine Design*
Hinton, W. A., *Heat Power*
Hixon, C. R., *Heat Power*
Hoefer, E. G., *Heat Power*
Hofmann, G. A., *Heat Power*
Holdredge, E. C., *Heat Power*
Holland, A. D., *Heat Power; Refrig.*
Holmes, A. G.
Holmes, C. W., *Heat Power; Mech. & Mat*
Holmes, W. J., *Heat Power, Mathematics*
Holowenko, A. R., *Mathematics*
Holtby, F., *Mfg. Proc.*
Horack, C. W., *Drawing*
Hoshall, H. B., *Drawing*
Howard, D. E., *Machine Design; Shop*
Huckert, J. W., *Mach. Des.; Heat Power*
Hugo, M. S.
Hull, W. L., *Aeronautics*
Hummel, J. G., *H-P.; Plants*
Hyland, P. H., *Power Plants*
Iversen, H. W., *Mechanics*
Jacklin, H. M.
Jackson, J. W., *Mathematics*
Jackson, W., *Mathematics*
Jacobus, D. S.
Jakob, Max, *Physics*
Jennings, B. H., *Heat Power; Refrig.*
Jett, C. C., *Mach. Design; Mech. & Mat*
Joerger, C. A., *Heat Power; Refrig.*
Johnson, C. G.
Johnson, R. H.
Johnson, W. A., *Machine Dsign*
Joice, C. B., *Mfg. Proc.*
Jonassen, Finn, *Civil*
Jones, J. B., *Heat Power; Refrigeration*
Jones, W. H., *Heat Power, Refrigeration*
Judd, H., *Hydraulics*
Kalelkar, B. D., *Mechanics*
Kauppinen, T. S.
Kavanaugh, D., *Heat Pr.; Mech. & Mat.*
Kayan, C. F., *Heat Power; Refrigeration*
Kaye, J., *Heat Power*
Keator, F. W., *Mfg. Proc.; Heat Power*
Keeler, H. E., *Heat Power; Electrical*
Keenan, J. H., *Heat Power*
Keith, J. I., *Food Eng.*
Kemler, E. W., *Petroleum*
Kenerson, W. H.
Kent, C. H., *Mech. & Mat.*
Kenyon, V. L., *Eng. Drawing*
Kiefer, P. J., *Heat Power; Power Plants*
King, J. A., *Heat Power, Refrigeration*
King, R. S., *Heat Power; Shop*
Kipp, H. L., *Machine Des.; Heat Power*
Kistler, P. N., *Mechanics and Materials*
Klein, G. W.
Knowles, M. G., *Heat Power; Physics*
Koenig, L. R., *Mach. Design*
Kohler, H. L., *Heat Power*
Kolb, R. P., *Heat Power; Power Plants*
Kozacka, J. S., *Machine Design*
Kroeger, H. R.
Kuhlen, Frederick, *Machine Design*
Kunkel, G. M., *Mach. Des.; Refrigeration*
Kurzweil, A. C., *Mechanics*
Kut, W. S., *Heat Power*
Kyle, P. E., *Mech. & Mat.*
Labberton, J. M., *Heat Power; Refrig.*
Laitala, E., *Industrial*
Lambertine, J. A., *Refrig. Heat Power*
Langdon, H. H., *Heat Power; Power Pls.*
Langille, H. B., *Mach. Des.; Eng. Draw.*
Larkin, F. V., *Industrial*
Larson, C. W.
Larson, G. L., *Heat Power; Refrigeration*
Larson, R. F., *Heat Power; Pet. & Nat. Gas*
Lease, L. J., *Indus. Coord.*
Lee, E. S.
Leet, H. W., *Drawing*
Leonard, C. M., *Heat Power; Power Pls*
Leutwiler, O. A., *Mechanics*
Leutwiler, R. W., *Mech. & Mat.*
Levens, A. S.
Lewellen, M. T., *Heat Power; Shop*
Lewis, A. D., *Aeronautics*
Lewis, R. E., *Eng. Draw.*
Lichty, L. C., *Heat Power*
Lindahl, E. J., *Heat Power*
Lindell, W. F., *Electrical*
Lindenmeyer, R. S., *Industrial*
Lloyd, H. R., *Mach. Des.; Mech. & Mat*
Lofgren, K. E., *Machine Design*
Loflin, Z. L., *Mechanics*
London, A. L., *Chemical*
Lucarini, G. B., *Heat Power; Refrig.*
Luce, A. W., *Mach. Des.; Mech. & Mat.*
Ludwickson, J. K., *Heat Power*
Ludy, L. V., *Heat Power*
Luebs, A. A., *Heat Power; Refrigeration*
Mack, A. J., *Heat Power*
Mackey, C. O., *Heat Power*
MacNaughton, E., *Mach. Des.; Heat Pr.*
Mallory, W. F.
Manifold, G. O., *Mach. Des.; Power Plants*
Marco, S. M., *Heat Power*
Marcoux, H. A., *Industrial*
Mariani, R. A.
Marin, A.
Marquis, F. W., *Heat Power; Power Pls*
Martin, B. W., *Mathematics*
Martin, C. E., *Metallurgy*
Martin, W. H., *Heat Power; Refrig.*
Mason, H. W., *Heat Power; Refrigeration*
Massey, J. T.
Matson, R. M., *Mach. Des.; Mech. & Mat*
Matthes, G. F., *Mech. & Mat.*
May, J. W., *Heat Power, Refrigeration*
Mayer, J. K., *Heat Power; Mech. & Mat.*
McAulay, H. J., *Power Plants*
McDonald, R. N.
McIntosh, W. G., *Machine Des.*
McIntyre, H. J., *Mach. Des.; Heat Power*
McKee, H. L., *Drawing*
McKee, W. S., *Machine Design*
McKergow, C. M.
McLellan, H. J.
McMinn, B. T., *Mech. & Mat.*
McNear, W. F., *Drawing*
Medlin, J. W., *Mechanics*
Merrick, C. M., *Mfg. Proc.; Industrial*
Messersmith, C. W., *Heat Power*
Miles, J. C., *Heat Power; P. Plants*
Miller, H. W., *Machine Design*
Miller, L. G., *Heat Power*
Miller, W. H.
Miller, W. T.
Minarik, R. G., *Mach. Design; Mfg. Proc.*
Ming, F. W., *Eng. Drawing*
Mochel, M. G., *Mechanics*
Moen, W. B., *Power Plants*
Moffat, G. N., *Machine Design*
Mohn, P. E., *Heat Power; Power Plants*
Moody, A. M. G.
Moody, L. F., *Hydr.; Mech. & Mat.*
Moore, E. R., *Drawing*
Moore, M. B., *Heat Power; Mech. & Mat.*
Morse, J. L., *Machine Design; Civil*
Morton, R. W., *Heat Power; Power Pls*
Moser, K. J., *Refrig.; Mech. & Mat.*
Moynihan, J. R., *Materials*
Munro, G. W., *Heat Power*

Murphy, E. F., ***Heat Power***
Nachman, H. L., ***Thermodynamics***
Nelson, D. W., ***Heat Power; Refrig.***
Nelson, E. W., ***Aeronautics***
Neugebauer, G. H., ***Mach. Des.; Refrig***
Nickelsen, J. M., ***Mech. & Mat.***
Nordenholt, G. F., ***Ed. Product Eng.***
Norman, C. A., ***Machine Design***
Nye, E. P., ***Heat Power***
Oberman, L. L.
Obert, E. F., ***Mach. Des.; H-P.***
O'Leary, A. M., ***Drawing***
Olsen, L., ***Mech. & Mat.***
Onuf, B. R., ***Heat Power***
Otto, L. L., ***Mech. & Mat.***
Owens, R. G., ***Physics***
Paddock, R. G., ***Heat Power; Power Pls.***
Palmer, D. M., ***Electrical***
Palmer, H. K., ***Machine Design***
Parker, E. B., ***Machine Design***
Parker, N. A., ***Aeronautics***
Parks, W. H., ***Aeronautics***
Pattison, Floyd, ***Min. Tech., metallurgy***
Payne, W. M., ***Machine Design***
Pearce, C. E., ***Machine Design; Aeron.***
Pence, W. D.
Perkins, D. L., ***Mfg. Proc.; Heat Power***
Pesman, G. J., ***Heat Power***
Petrie, G. W., ***Mathematics***
Phelps, C. W., ***Heat Power***
Philbrick, H. S., ***Heat Power***
Pinsky, Jos., ***Heat Power***
Pitt, R. St. C.
Planck, I. A., ***Drawing***
Polaner, J. L., ***Heat Power***
Porter, L. M., ***Machine Design***
Potter, J. H., ***Mech. & Mat.***
Potter, P. J., ***Industrial***
Powers, L. J., ***Pet. & Nat. Gas***
Prageman, I. H., ***Machine Design; Indus.***
Prian, V. D., ***Mfg. Processes; Industrial***
Price, L. C., ***Mach. Design; Heat Power***
Price, M. L., ***Mach. Des.; Mechanics***
Priester, G. B., ***Heat, Refrig.***
Prior, J. A., ***Mach. Des.; Mech. & Mat.***
Progner, F., ***Machine Design***
Pyler, O. G.
Quier, K. E., ***Drawing***
Quinn, B. E., ***Drawing***
Raber, B. F., ***Heat Power; Refrigeration***
Rahm, L. F., ***Machine Design; Mfg Proc.***
Rasche, W. H.
Reaser, W. E., ***Heat Power***
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Reed, J. C., ***Heat Power; Civil***
Renwick, D. J., ***Eng. Drawing***
Repscha, A. H., ***Heat Power; Power Pls.***
Rice, R. B., ***Mechanics and Materials***
Rich, N. H., ***Heat Power***
Richtmann, W. M., ***Heat Power***
Riddle, K. W., ***Machine Design; Shop***
Riebeth, T. J., ***Drawing***
Riederer, F. W., ***Drawing***
Risteen, H. W., ***Heat Power; Refrig***
Roberts, C. P., ***Heat Power***
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Robertson, B. J., ***Heat Power; Aeron.***
Robinson, O. L., ***Fire Protection***
Robinson, Walter
Rodes, H. P., ***Drawing***
Roemmele, H. F., ***Heat Power; Pr. Pls.***
Roesch, D., ***Automotive***
Rogers, F. S., ***Machine Design***
Rohrbach, G. E., ***Heat Power***
Roop, F. S., ***Heat Power; Power Plants***
Roudebush, R. E., ***Industrial***
Royer, W. C., ***Drawing***
Rubenkoenig, Harry, ***Mech. & Mat.***
Russell, D. M., ***Heat Power***
Ruten, W. H., ***Shop***
Ryan, D. G., ***Industrial***
Ryan, J. J., ***Machine Design***
Sager, E. H., ***Mfg. Proc.***
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Schneider, T. A.
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Schuck, R. F., ***Machine Design***
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Seward, H. L., ***Heat Power***
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Short, B. E., ***Heat Power***
Shumaker, C. H., ***Heat Power***
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Simon, G. H., ***Heat Power; Power Plants***
Sims, E. M., ***Heat Power; Power Plants***
Skoglund, V. J., ***Heat Power***
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Smith, R. K., ***Eng. Drawing***
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Stanley, C. M., ***Textile***
Staples, A. J., ***Heat Power; Min. Tech***
Starr, C., ***Shop***
Stearns, F. A., ***Heat Power***
Steele, A. L.
Stefani, Luis, ***Mach. Des.; Heat Power***
Stetkewicz, J. D., ***Metallurgy***
Stetson, G. A., ***Mech. & Mat.; Economics***
Stevens, H. E., ***Machine Design; Indus.***
Stevens, W. J., ***Mach. Des.; Mfg. Proc.***
Stiening, F. H., ***Mach. Des.; Refrig.***
Stinson, K. W., ***Heat Power***
Stoever, H. J., ***Heat Power***
Stolworthy, E. H., ***Aeron.; Eng. Drawing***
Strate, J. T., ***Heat Power; Refrigeration***
Stuart, H. F., ***Heat Power***
Stuart, M. C., ***Heat Power; P. Plants***
Sullivan, F. J., ***Mach. Des.; Eng. Draw.***
Summers, R. E., ***Power Plants***
Svenson, C. L., ***Heat Power; Refrig.***
Sweigert, R. L., ***Heat Power***
Swett, G. W., ***Mach. Des.; Mech. & Mat.***
Swift, R. E., ***Metallurgy***
Swineford, C. R., ***Mach. Des.; Eng. Draw.***
Taft, T. H., ***Heat Power; Power Plants***
Tait, R. S., ***Machine Design***
Teal, E. A., ***Industrial***
Terrell, W. P.
Thatcher, C. G., ***Heat Pr.; Mech. & Mat.***
Theiss, E. S., ***Industrial***
Thom, G. B., ***Heat Power; Refrigeration***
Thomas, F. H., ***Mfg. Processes; Indus.***
Thompson, J. G. H., ***Mach. Des.; Mfg. Proc.***
Thompson, L. P., ***Mathematics***
Thornburg, M. L., ***Heat Power; Refrig.***

Tracy, S. J., *Mach. Des.; Heat Power*
Trent, C. E., *Machine Design*
Trigger, K. J., *Mfg. Proc.; Heat Power*
Tripp, Wilson, *Heat Power*
Trotter, R. A., *Machine Design*
Truettner, W. I., *Aeronautics*
Trummel, J. M., *Machine Design*
Trumpler, P. R., *H-P.; Power Plants*
Tucker, J. M., *H-P.; Refrig.*
Tucker, R. R., *H P; Power Plants*
Tuthill, A. F.
Tutt, C. L., *Mach. Des., Mfg. Proc.*
Tuve, G. L., *Heat Power*
Tyrrell, C. C., *Mechanics and Materials*
Ulcher, J. J., *Heat Power*
Updegrove, H. T., *Mfg. Proc.; Industrial*
Upp, C. R., *Heat Power; Power Plants*
Van Driest, E. R., *Civil*
Van Dyke, J. R., *Drawing*
Venn, R. E., *Drawing*
Vidosic, J. P.
Vincent, E. T., *Heat Power*
Vissat, P. L., *Physics*
Vittucci, R. V., *Heat Power; Refrig*
Vopat, W. A., *Heat Power; Power Plants*
Vose, F. H., *Heat Power; Power Plants*
Walter, H. E., *Heat Power*
Warren, A. J., *Aeronautics*
Waterfall, H. W., *Mach. Des.; Power Pl.*
Waters, E O., *Mach. Des.; Mech. & Mat.*
Watson, H. D., *Heat Power*
Weber, A. R, *Heat Power*
Webster, F. N., *Power Plant*
Weibel, E. E., *Mechanics*
Weiland, W. F., *Pet. & Nat. Gas*
Weishampel, J. A., *Mech. & Mat.*
Weiss, H. A., *Ind. Eng.; Machine Design*
Weiss, J. R., *Power Plants*
Welch, H. E., *Practical Science*
Wetzel, I. T., *Electrical*
Wilbur, R. S., *Heat Power*
Wilcox, C. C., *Power Plant*
Williams, M. O, *Aeronautical*
Williams, G. K., *Aeronautical*
Willis, P. A., *General; Industrial*
Wilson, H. A., *Machine Design*
Wilson, L. A., *Heat Power; Refrigeration*
Wingren, R. M., *Mach Des.; Mech. & Mat*
Winston, S. E, *Mach. Des.; Heat Power*
Wischmeyer, Carl, *Heat Power; Refrig*
Wohlenberg, W. J.
Woods, B. M., *Industrial*
Wright, H. M., *Heat Power*
Yavitch, J.
Young, A. P., *Mech. & Mat.*
Young, C. H., *Machine Design; Indus.*
Young, E. G., *Mach. Des.*
Young, V. W., *Aeronautics*
Younger, J. E., *Aeronautics*
Zarobsky, I. F., *Mach. Des.; Eng. Draw.*
Zbell, S. P., *General; Draw.*
Zeller, J. W.

MECHANICS AND MATERIALS

Adams, R. G.
Aubert, Bro. J., *Civil*
Avey, H. T.
Backer, G. H., *Aeronautics*
Beal, R. W., *Mechanical, heat power*
Bechtold, C. W.
Berryman, L. G., *Metallurgy*
Bliss, Z. R., *Economics; Machine Design*
Boomsliter, G. P., *Mechanical; Civil*
Boyd, J. E.
Breneman, J. W., *Civil Eng.*
Brown, F. L.
Bullard, J. A., *Mathematics*
Cade, C. M., *Civil, surveying*
Carey, R. H., *Civil, structural*
Cassel, E. B., *Drawing*
Cather, C. H., *Mechanical; Mach. Design*
Chamberlin, S. J., *Civil; Eng. Drawing*
Chambers, S. D., *Civil*
Clark, E. C., *Structural*
Clark, L. W., *Struc.*
Colbert, J. P., *Civil, structural*
Collins, W. L., *Civil, structural*
Conley, W. J., *Civil*
Conner, N. W., *Mechanical; Aeronautics*
Cornell, W. R., *Mechanical*
Cox, W. J., *Civil*
Cutshall, C. S., *Chemical*
Dahlene, Oscar, *Mathematics*
Davis, A. W.
De Baufre, W. L., *Mech.; Eng. Drawing*
Dietz, A. G. H., *Bldg. Eng.*
Dodge, R. A., *Hydraulics*
Doerr, L. O., *Mechanical, machine design*
Dohrenwend, C. O., *Civil; Mathematics*
Dolan, T. J., *Civil; Mechanical*
Doll, A. W., *Physics*
Donnell, L. H., *Aeronautics*
Dougherty, J. W.
Downing, D. G., *Engineering Drawing*
Draffin, J. O., *Civil; Sanitary*
Dudley, W. M., *Mechanical, Mach. design*
Duff, C. M., *Civil*
Eberhart, H. D., *Civil*
Edgar, R. F., *Civil; Drawing*
Ensign, N. E., *Mathematics*
Eriksen, E. L., *Civil; Aeronautics*
Ernst, G. C., *Civil, structural*
Evans, T. H., *Civil, structural*
Everett, F. L., *Machine Design*
Fairman, Seibert, *Aeronautics*
Findley, W. N.
Flanders, R. L., *Civil*
Folk, S. B., *Civil, hydraulics*
Frigon, R. A., *Mechanical*
Frocht, M. M., *Machine Des.; Math.*
Fuller, C. E.
Gilkey, H. J., *Civil*
Girvin, H. F., *Mechanical; Industrial*
Goodier, J. N., *Mathematics*
Griffis, L.
Grone, E. A., *Drawing*
Haddox, L. C., *Physics*
Hagerty, W. W., *Machine Design*
Harris, C. O., *Structural*
Hartenberg, R. S., *Math; Aeronautics*
Hawkins, R. D., *General*
Herrick, C. A., *Mechanical; Mathematics*
Herrick, T. J., *Mechanical*
Higdon, R. A., *Mathematics*
Higgins, P. R., *Aeronautics*
Hill, F. M., *Drawing*
Holme, J. M., *Mathematics*
Howe, J. W., *Hydraulics*
Howell, E. V., *Mathematics*
Hudson, R. C., *Drawing*
Hundley, R. E., *Mathematics*
Jackson, J. W., *Mechanical*
James, R. V., *General*
Jensen, A., *Arch. Eng.*
Johnson, A. M.
Jones, R. W., *Mathematics*
King, H. J., *Mechanical*
Kingman, E. D., *English*
Koenitzer, L. H., *Civil, hydraulics*
Kommers, J. B., *Mechanical; Mach. Des.*
Lansford, W. M., *Civil, hydraulics*
Laurson, P. G., *Civil, structural*
Lee, G. H., *Mathematics*
Lightburn, F. E., *Highway*
Lissner, H. R., *Aeronautics*
Lowcke, G. P.
MacCullough, G. H., *Mechanical*
Mangold, J. P.
Mansky, C. B., *Mathematics*

.)seph,
Maurer, E. R.
Mayrose, H. E., *Mechanical*
McLean, W. G., *Mathematics*
Meigs, H. H.
Miller, F. E., *Mathematics*
Miller, P. F.
Moore, H. F., *Mechanical; Metallurgy*
Morkovin, D., *Mechanical*
Murphy, Glenn, *Civil, structural*
Myklestad, N. O., *Mechanical*
Newman, M. K., *Physics*
Oberman, L. L.
Ockerblad, A. M., *Civil*
Ohlsen, E H., *Structural*
Olsen, G. A., *Mech. & Mat.*
Ormondroyd, J.
Ott, P. W., *Civil, hydraulics*
Paul, C. E., *General Eng.*
Peck, J. S., *Structural; Psychology*
Perkins, H. C., *Mechanical; shop*
Peterson, A. C., *Sanitary*
Peterson, F. G. E., *Civil*
Pletta, D. H.
Pohl, F. V.
Poorman, A. P., *Civil, structural*
Powell, R. W., *Civil, hydraulics*
Preston, H. K., *Civil*
Priester, G C., *Mathematics*
Puckett, H. P., *Mechanical*
Rackway, J. S., *Drawing*
Reardon, L. J.
Richmond, R. F., *Drawing*
Roark, R. J., *Aeronautics; C. E.*
Robert, J. H., *Civil, hydraulics*
Sanders, W. B., *Chemical*
Sayre, M. F., *Mechanical*
Scholer, C. H., *Civil, structural*
Schoonover, R. H., *Structural; Math*
Schrader, H. J., *Mechanical*
Seely, F. B., *Mech.; Civil, hydraulics*
Singer, F L., *Mech.; Eng. Drawing*
Smith, F. H., *Drawing*
Smith, G. W., *Civil*
Smith, J. O., *Mathematics*
Staley, H. R., *Civil*
Stephen, E. R., *Mechanical, mach. des.*
Stiles, W. B., *Electrical, illumination*
Stitz, E. O, *Chemical*
Sturm, R. G., *Civil*
Tarpley, C. E., *Mineral Tech*
Taskin, H. K., *Heat Power*
Taylor, D. C., *Civil; Foreign Lang*
Thomas, Evan, *Mathematics*
Throop, J. F., *Civil*
Timoshenko, S. P.
Topping, A. N., *Civil*
Trathen, R. H.
Tucker, LeRoy, *Civil; Geology*
Vennard, J. K., *Hydraulics*
Vierck, R. K, *Mechanical*
Wade, F. H, *Hydraulics*
Ward, Sam., *Civil*
Wendt, K. F, *Civil*
Whetstone, G. A., *Mathematics*
Williams, G. K., *Electrical*
Williams, R. Z., *Metallurgy*
Williams, W. E., *Hydraulics*
Wiseman, E R., *Civil*
Withey, M O., *Civil*
Wood, E. H.
Worrell, D. T., *Power*
Young, Dana

MINERAL TECHNOLOGY

Barker, G. J., *Chem. Eng.*
Berry, G. M., *Metallurgy; Shop*
Black, R. M., *Mining*
Bolotsky, Max, *Metallurgy*
Bottomley, J. A., *Civil*
Brick, R. M., *Metallurgy*
Brown, R. L.
Bucky, P. B., *Mining*
Butts, Allison, *Metallurgy*
Carpenter, A H., *Metallurgy; Geology*
Clayton, C. Y., *Metallurgy*
Cloud, W. F., *Pet. & Nat. Gas*
Cockrell, W. L., *Metallurgy; Chemical*
Coffinberry, A. S., *Metallurgy*
Cothern, L. I.
Cover, G. M., *Metallurgy*
Craft, B. C., *Pet. & Nat. Gas; Geology*
Cunningham, J. B., *Mining; Metallurgy*
Daniels, Joseph, *Mining; Metallurgy*
Demorest, D. J., *Chemical*
Doan, G. E., *Metallurgy*
Dodge, J. F., *Petroleum and Natural Gas*
Dowdell, R. L., *Metallurgy*
Drier, R. W., *Metallurgy; Physics*
Eckfeldt, Howard, *Mining; Min. Dressing*
Eddy, C. T., *Metallurgy*
Fitterer, G. R., *Metallurgy*
Forrester, J. D., *Mining*
Frye, J. H., *Metallurgy*
Gallagher, R. T., *Mining*
Gaudin, A. M., *Mineral Dressing*
Gonzalez, O., *Metallurgy*
Good, A. C., *Metallurgy*
Goodale, S. L., *Metallurgy*
Grawe, O R., *Geology*
Greaves-Walker, A. F., *Ceramics*
Grider, R. L., *Mining; Eng. Drawing*
Grosvenor, A. W., *Metallurgy*
Gudebski, H. C., *Metallurgy*
Haga, L. J., *Chemical*
Hess, W. F., *Met.; Physics; Elec. E.*
Hoffman, P. O.
Horn, C. R., *Pet. & Nat. Gas*
Jacobs, R. K.
Joseph, T. L., *Metallurgy*
Kehl, G. L., *Metallurgy*
Krumlauf, H. E., *Mining*
Lazan, B. J., *Metallurgy*
Lewis, J. F., *Mining; Pet. & Nat. Gas*
Lewis, R. S., *Mining; Mineral Dressing*
Lissner, H. R., *Aeronautics*
Locke, C. E., *Mining; Mineral Dressing*
MacIntosh, A. N.
Mackay, Scott, *Metallurgy*
Mahin, G. E., *Metallurgy*
Manderfield, N. H., *Metallurgy; Chemical*
Mathewson, C. H., *Metallurgy*
Mathiesen, J. T., *Geography*
Mauffette, P., *Mining, Geology*
McCauley, R. B., *Metallurgy*
Miller, E. C., *Metallurgy; Min. Dress*
Milligan, W. E., *Metallurgy; Chemistry*
Nelson, W. L., *Pet. & Nat. Gas*
Newcombe, J. A., *Metallurgy*
Noble, G. W., *Economics*
Nold, H. E., *Mining*
Ockerblad, A. M., *Surveying*
Parker, W. H., *Mining; Pet. & Nat Ga*
Parks, J. M., *Metallurgy*
Peretti, E. A. J., *Metallurgy*
Phillips, Arthur, *Metallurgy*
Plank, W. B., *Mining; Metallurgy*
Power, H. H., *Pet. & Nat. Gas; Chemical*
Queneau, B. R., *Metallurgy*
Quier, K. E., *Heat Power, Power Plants*
Raudebaugh, R. J., *Metallurgy*
Read, T. T., *Mining*
Ross, F. W., *Mathematics*
Schneidewind, R., *Metallurgy*
Schramm, E. F., *Gas & Geology*
Schulte, W. C., *Metallurgy; Mechanical*
Schuhmann, R.
Serviss, F. LeV., *Geology*
Shaffer, R. E., *Metallurgy*

Sherman, G. W., *Metallurgy*
Sherrill, R. E., *Gas & Geology*
Snelgrove, A. K., *Mining & Geology*
Spindler, W. A., *Metal Proc.*
Stephenson, E. A., *Pet. and Nat. Gas*
Stewart, J. W., *Mining*
Straley, H. W., *Geophysics*
Stuckey, J. L., *Geology*
Swift, R. E., *Metallurgy*
Taggart, A. F., *Min. Dressing; Chemical*
Talmage, S. B., *Mining; Geology*
Underhill, James, *Mining; General*
Upthegrove, C., *Metallurgy*
Uren, L. C., *Petroleum*
Vance, Harold, *Pet. and Natural Gas*
Van Note, W. G., *Ceramics*
Sherman, G. W., *Metallurgy*
Wagner, H. A., *Mining; Metallurgy*
Walker, H. L., *Metallurgy*
Weysser, J. L. G., *Metallurgy*
White, H. V., *Metallurgy*
Wilkinson, M. W., *Metallurgy*
Witmer, L. F., *Metallurgy*
Wyant, R. A., *Metallurgy*

NAVAL ARCHITECTURE

Adams, H. C.
Baier, L. A., *Marine Eng.*
Curran, T. M., *Mechanical*
Keith, H. H. W., *Marine Eng*
O'Connor, G. R., *Mechanical*

PHYSICS

Abbitt, W. H., *Metallurgy*
Albright, J. G., *Surveying*
Albright, P. S.
Applegate, C. E., *Electrical*
Banks, C. W., *Civil; Mech. & Mat*
Barthel, C. E., *Personnel*
Bartlett, G W.
Bennett, C. E *Mathematics*
Bessey, W. H., *General Eng.*
Billhartz, W. H., *Electrical*
Birge, R. T.
Bishop, F. L.
Bliss, H. H., *Gen. Eng.*
Brewington, G. P., *Mathematics*
Brown, F. L., *Mathematics*
Burg, W. V., *Chemical*
Carlisle, D. F., *Communications*
Chase, C. T.
Childs, H. R.
Clouse, J. H., *Mechanical; Mech & Mat*
Collins, G. B., *Electrical*
Colvert, W. W., *Mathematics*
Coolidge, J. A., *Mathematics*
Copeland, P. L.
Driscoll, W G., *Mathematics*
Duncan, David C., *Mathematics*
Duncan, Donald S., *Mathematics*
Durbin, F. M.
Entwisle, F. N., *Psychology*
Fraim, P B., *Geology*
Fry, H. M., *Electrical; Mathematics*
Gager, F. M., *Electrical; General*
Grantham, G. E.
Guthrie, A. N.
Gwinn, I. J., *Engineering Drawing*
Hall, V. B., *Eng. Drawing; Mechanical*
Halsey, Hugh
Hammond, T. M., *Mathematics*
Hawkes, J. B.
Hazell, W., *Electrical*
Hazeltine, L. A., *Mechanical*
Hedenberg, N. A., *Aeronautics*
Heil, L. M., *General*
Heller, R., *Mathematics*
Henderson, R. B.
Herreman, H. M., *Electrical*
Hertel, K. L., *Mathematics*
Hett, J. H., *Mathematics*
Hilberry, Norman
Hottle, W. M., *Electrical*
Howes, H. L., *General*
Howey, J. H.
Ingersoll, L. R., *Heat Power*
Jackson, K. B., *Surveying*
Johnson, C. F., *Mathematics*
Johnson, L. V.
Jones, L. W., *Electrical, communication*
Jones, M. W., *Civil*
Kenrick, G. W., *Electrical, commun.*
Kirkpatrick, E. L., *Radio Design*
Kovarik, A. F., *Mathematics*
Lambe, E. P., *Electrical, power*
Lancaster, F. W., *Chemistry; Math.*
Lark-Horovitz, K.
Longacre, W. A., *Mechanics*
MacDonnell, R. B., *Mechanics*
Mallory, F.
Meares, J. S.
Merritt, H. W., *Mechanics and Materials*
Miller, E. F.
Mills, P. J., *Acoustics*
Moore, K. H.
Muckenhoupt, C. F., *Electrical; Math.*
Mullen, C. F.
Myers, F. E.
Nielsen, P. E.
Partlo, F. L., *Mathematics*
Patterson, R. A.
Pheley, D. B., *Civil, surveying*
Pietenpol, W B., *Mathematics*
Pomeroy, G. A.
Porter, R. A.
Potter, J. G., *General Enginering*
Prosser, E. T.
Pugh, E. M., *Electrical*
Ravenscroft, H. A
Richardson, D. E., *Communications*
Robert, R. A., *Mathematics*
Rosselot, G. A., *Communication*
Sagen, G. O., *Mathematics*
St. Peter, W. N.
Sartain, C. C., *Electrical*
Seitz, F., *Chemistry*
Sermon, T. C., *Mechanics*
Silvey, O. W., *Mathematics*
Slack, E. P., *Electrical*
Slack, F. G
Smith, E. G., *Mechanical*
Soltau, D. L., *Civil*
Spinney, L. B., *Electrical*
Stempel, W. M., *Optics*
Stewart, G W
Sturgis, H. W.
Swaim, V. F., *Mathematics*
Thompson, J. S.
Varteressian, K. A., *Chemical*
Warfield, C. N., *Aeronautics*
Wasson, H. P., *Mathematics*
Webster, J. C., *Mechanical; General*
Whitaker, M. D.
Woodbury, C. V., *Aeronautics*
Woodrow, J. W., *Mathematics*
Woods, F. P.

PSYCHOLOGY

Boder, D. P., *Industrial Eng.*
Carter, C. C
Hanson, A. E., *Ind. Ed.*
Hicks, W. N., *Ethics & Religion*
Johnson, A. P., *Personnel & Indus. Rel.*
Kopas, J. S., *Electrical, communication*
Magoun, F. A.
O'Connor, Johnson
Palmerton, L. R.
Porter, J. M., *Meas. Guidance*

Schaefer, V. G.
Swartz, B. K., *Economics*

SANITARY ENGINEERING

Babbitt, H. E., *Chemistry; Civil*
Boyce, Earnest, *Civil*
Brown, E. S., *Civil, surveying*
Cheek, F. J., *Hydraulics*
Dunstan, G. H., *Hydraulics*
Eliasson, R., *Hydraulics*
Fair, G. M.
Gard, C. M., *Hydraulics*
Gotaas, H. B., *Civil, hydraulics*
Haney, P. D., *Chemical*
Hinman, J. J., *Chemical; Chemistry*
Howland, W. E., *Civil, hydraulics*
Hyde, C. G., *Civil*
Jones, D. K., *Hydraulics*
Kilcawley, E. J., *Soil Mech.*
Miles, H. J., *Civil, hydraulics*
Nichols, M. S., *Chemistry*
O'Donnel, Raymond, *Civil, hydraulics*
Payrow, H. G., *Civil, hydraulics*
Perry, Lynn, *Civil, surveying*
Pettis, C. R., *Water Supply*
Rohlich, G. A., *Hydraulics*
Scott, J. E., *Shop*
Sellner, E. P., *Construction*
Stanley, W. E., *Civil, hydraulics*
Stapley, E. R., *Civil, hydraulics*
Steel, E. W., *Civil*
Stiemke, R. E., *Hydraulics*
Suttie, R. H., *Civil, hydraulics*
Vander Velde, T. L., *Civil, surveying*
Walker, C. L., *Civil*
Waterman, E. L., *Civil*
Wolman, Abel, *Hydraulics*

SHOP AND MECHANIC ARTS

Beatty, H. R., *General; Industrial*
Benedict, Otis, *Mechanical, mach. design*
Bigelow, R. G., *Industrial*
Bjerg, H. O., *Drawing*
Bradley, F. R.
Brickler, A. J.
Burley, J. W., *Mechanical*
Carlson, W. W., *Mechanical*
Carr, F. J.
Delenk, W. N., *Mfg. Proc.*
Hoy, H. H., *Mechanical*
Hunt, De Witt, *Safety*
Johnson, C. G., *Metallurgy*
Jones, C. B., *Forging, heat treating*
Kepler, F. R.
Lindley, R. W.
Nesbitt, R. E., *Mechanical*
O'Rourke, F. J.
Portella, M. M.
Rix, C. N., *Mechanical*
Rowland, M. R., *Mechanical; Eng. Draw.*
Soderstrom, E. D.
Starr, C. J., *Mechanical, mfg. processes*
Tonkin, J. C., *Mechanical, mfg. processes*
Trueblood, R. B., *Mechanical*
Welch, H. E., *Drawing*
Wendt, R. E., *General*
Wittig, F. E., *Heat Power*

TOTAL MEMBERS, PAST AND PRESENT.

INDIVIDUAL

Aug. 20, 1894	156	
Sept. 2, 1895	184	
Aug. 20, 1896	200	(about)
Aug. 16, 1897	203	
Aug. 18, 1898	226	
Aug. 17, 1899	238	
July 2, 1900	249	
June 29, 1901	261	
June 27, 1902	253	
July 1, 1903	271	
Sept. 1, 1904	325	
June 28, 1905	379	
July 2, 1906	400	
July 1, 1907	415	
June 27, 1908	675	
June 24, 1909	759	
June 23, 1910	848	
June 27, 1911	1,071	
June, 1912	1,102	
June, 1913	1,158	
March, 1914	1,339	
July 1, 1915	1,452	
March, 1916	1,504	
March, 1917	1,505	
March, 1918	1,506	
April, 1920	1,511	
April, 1922	1,589	
March, 1923	1,694	
March, 1926	1,988	
June, 1927	1,995	
May, 1928	2,025	
Nov., 1929	2,169	
Nov. 1, 1930	2,192	
Nov. 30, 1931	2,274	
Nov. 8, 1932	2,227	
Jan. 27, 1934	2,271	
Jan. 1, 1935	2,453	
Feb., 1, 1937	2,490	
Feb. 10, 1938	2,901	
Feb. 1939	2,929	
Feb. 1940	3,086	
Feb. 1941	3,220	
Feb. 1942	3,269	
Feb. 1943	3,426	
Feb. 1944	3,855	
Feb. 1945	3,787	

Individual Members	3,787
Institutional Members	161
Total Membership	3,948

MEETINGS OF THE S. P. E. E.

1893, July 30–Aug. 5	Chicago, Ill.*	I. O. Baker, Univ. of Ill. (Chairman, Section E.)
1894, Aug. 20–21	Brooklyn Polytechnic Institute, Brooklyn, N. Y.	DeVolson Wood, Stevens Inst. of Technology.
1895. Sept. 2–4	Springfield, Mass.	G. F. Swain, Massachusetts Inst. of Technology.
1896, Aug. 20–22	Buffalo, N. Y.	Mansfield Merriman, Lehigh Univ.
1897, Aug. 16–18	University of Toronto, Toronto, Ontario.	H. T. Eddy, Univ. of Minn.
1898, Aug. 18–20	Boston, Mass.	J. B. Johnson, Wash. Univ., Missouri.
1899, Aug. 17–19	The Ohio State University, Columbus, O.	T. C. Mendenhall, Worcester Polytechnic Inst.
1900, July 2–3	Columbia University, New York City.	I. O. Baker, Univ. of Ill.
1901, June 29–July 2	Buffalo, N. Y.	F. O. Marvin, Univ. of Kans.
1902, June 27–28	Pittsburgh, Pa.	Robert Fletcher, Dartmouth College.
1903, July 1–3	Niagara Falls, N. Y.	C. M. Woodward, Wash Univ., St. Louis.
1904, Sept. 1–3	St Louis, Mo.	C. F. Allen, Mass. Inst. of Technology.
1905, June 28–29	Atlantic City, N. J.	F. W. McNair, Mich. Coll. of Mines.
1906, July 2–3	Cornell University, Ithaca, N. Y.	C. L. Crandall, Cornell Univ.
1907, July 1–3	Case School of Applied Science, Cleveland, O.	D. C. Jackson, M. I. T.
1908, June 24–27	Detroit, Mich.	Chas. S. Howe, Case School of Applied Science.
1909, June 24–26	Columbia University, New York City.	F. E. Turneaure, Univ. of Wis.
1910, June 23–25	University of Wisconsin, Madison, Wis.	H. S. Munroe, Columbia Univ.
1911, June 27–29	Carnegie Institute of Technology and the University of Pittsburgh, Pittsburgh, Pa.	A. N. Talbot, Univ. of Ill.
1912, June 26–29	M. I. T., Harvard and Wentworth, Boston, Mass.	W. G. Raymond, Univ. of Iowa.
1913, June 24–26	University of Minnesota, Minneapolis, Minn.	W. T. Magruder, Ohio State Univ.
1914, June 23–26	Princeton University, Princeton, N. J.	G. C. Anthony, Tufts College, Mass.
1915, June 22–25	Iowa State College, Ames, Ia.	Anson Marston, Iowa State College.
1916, June 19–22	University of Virginia, University, Va.	H. S. Jacoby, Cornell Univ.
1917, July 6–7	Washington, D. C.	G. R. Chatburn, Univ. of Neb.
1918, June 26–29	Northwestern University, Evanston, Ill	M. S. Ketchum, Univ. of Colo.
1918, December 6–7 †	Cambridge, Mass.	J. F. Hayford, Northwestern University.

* Meeting of Section E, Engineering Education, of the World's Engineering Congress, at which the S. P. E. E. was organized.

† Joint Meeting with the British Educational Mission to the United States. The meeting was called at the request of the Committee on International Relations of the American Council on Education.

1919, June 25–28	Johns Hopkins University, Baltimore, Md.	J. F. Hayford, Northwestern University.
1920, June 29–July 2	University of Michigan, Ann Arbor, Mich.	A. M. Greene, Jr., Rensselaer Polytechnic Inst.
1921, June 28–July 1	Yale University, New Haven, Conn.	M. E. Cooley, Univ. of Mich.
1922, June 20–23	University of Illinois, Urbana, Ill.	C. F. Scott, Sheffield Sci. School of Yale Univ.
1923, June 20–23	Cornell University, Ithaca, N. Y.	C. F. Scott, Sheffield Sci. School of Yale Univ.
1924, June 25–28	University of Colorado, Boulder, Colo.	P. F. Walker, Univ. of Kans.
1925, June 16–20	Union College, Schenectady, N. Y.	A. A. Potter, Purdue Univ.
1926, June 16–18	State University of Iowa, Iowa City, Ia.	G. B. Pegram, Columbia Univ.
1927, June 27–30	University of Maine, Orono, Maine.	O. M. Leland, Univ. of Minn.
1928, June 26–29	University of North Carolina, Chapel Hill, N. C.	R. L. Sackett, Penna. State College.
1929, June 19–21	The Ohio State University, Columbus, Ohio.	Dexter S. Kimball, Cornell University.
1930, June 26–28	Ecole Polytechnique, McGill University, Montreal, Canada.	R. I. Rees, American T. & T. Co.
1931, June 17–19	Purdue University, Lafayette, Ind.	H. S. Boardman, University of Maine.
1932, June 29, 30–July 1	Oregon State College, Corvallis, Ore.	H. S. Evans, University of Colorado.
1933, June 27–30	Stevens Hotel, Chicago, Ill.	R. A. Seaton, Kansas State College.
1934, June 19–23	Cornell University, Ithaca, N. Y.	W. E. Wickenden, Case School of Applied Science.
1935, June 24–27	Georgia School of Technology, Atlanta, Ga.	C. C. Williams, State University of Iowa.
1936, June 23–26	University of Wisconsin, Madison, Wis.	D. S. Anderson, Tulane University.
1937, June 28–July 2	Massachusetts Institute of Technology and Harvard University, Cambridge, Mass.	H. P. Hammond, Polytechnic Institute of Brooklyn.
1938, June 27–30	A. & M. College of Texas, College Station, Texas.	S. B. Earle, Clemson College.
1939, June 19–23	Pennsylvania State College, State College, Pa.	K. T. Compton, Mass. Inst. of Tech.
1940, June 24–28	University of California, Berkeley, Calif.	O. J. Ferguson, University of Nebraska.
1941, June 27–30	University of Michigan, Ann Arbor, Mich.	D. B. Prentice, Rose Polytechnic Institute
1942, June 29–July 2	New York City	A. H. White, University of Michigan.
1943, June 18–20	Illinois Institute of Technology, Chicago, and Northwestern University, Evanston, Ill.	H. T. Heald, Illinois Institute of Technology.
1944, June 25–28	University of Cincinnati, Cincinnati, Ohio.	Robert E. Doherty, Carnegie Institute of Technology.
*1945, June 21–24	Washington University, St. Louis, Mo.	H. S. Rogers, Polytechnic Institute of Brooklyn.

* Cancelled at request of War Committee on Conventions, Office of Defense Transportation.

SUMMER SCHOOLS FOR ENGINEERING TEACHERS.

HARRY P. HAMMOND, *Director.*

1927—Engineering Mechanics, Cornell University.
1927—Engineering Mechanics, University of Wisconsin.
1928—Electrical Engineering, University of Pittsburgh, and Westinghouse E. & M. Company.
1928—Physics, Massachusetts Institute of Technology.
1929—Mechanical Engineering, Purdue University.
1930—Civil Engineering, Yale University.
1930—Engineering Drawing and Descriptive Geometry, Carnegie Institute of Technology.
1931—Chemical Engineering, University of Michigan.
1931—Mathematics, University of Minnesota.
1932—Economics, Stevens Institute of Technology.
1932—English, The Ohio State University.
1933—Mining and Metallurgy, University of Wisconsin.
1933—Conference of Administrative Officers, University of Wisconsin.
*1945—Engineering Drawing.

* Cancelled at request of War Committee on Conventions, Office of Defense Transportation

PAST OFFICERS.

Special Committee for Division E, Engineering Education, World's Engineering Congress, 1893.

IRA O. BAKER,* Chairman,
WM. R. HOAG, Secretary,
MORTIMER E. COOLEY,*
HENRY T. EDDY,* Vice-Chairman,
C. FRANK ALLEN, Sec'y, *pro tem.*,
SAMUEL W. STRATTON,*
STORM BULL.*

PRESIDENTS.

DE VOLSON WOOD,* 1893–4,
GEORGE F. SWAIN,* 1894–5,
M. MERRIMAN,* 1895–6,
HENRY T. EDDY,* 1896–7,
JOHN B. JOHNSON,* 1897–8,
T. C. MENDENHALL,* 1898–9,
IRA O. BAKER,* 1899–1900,
FRANK O. MARVIN,* 1900–1,
ROBERT FLETCHER,* 1901–2,
CALVIN M. WOODWARD,* 1902–3,
C. FRANK ALLEN, 1903–4,
FRED W. McNAIR,* 1904–5,
CHARLES L. CRANDALL,* 1905–6,
DUGALD C. JACKSON, 1906–7,
CHARLES S. HOWE,* 1907–8,
FRED. E. TURNEAURE, 1908–9,
HENRY S. MUNROE,* 1909–10,
ARTHUR N. TALBOT,* 1910–11,
WM. G RAYMOND,* 1911–12,
WM. T. MAGRUDER,* 1912–13,
G. C. ANTHONY,* 1913–14,
ANSON MARSTON, 1914–15,
HENRY S. JACOBY, 1915–16,
GEORGE R. CHATBURN,* 1916–17,
MILO S. KETCHUM,* 1917–18,
JOHN F. HAYFORD,* 1918–19,
A. M. GREENE, JR., 1919–20,
MORTIMER E. COOLEY,* 1920–21,
C. F. SCOTT,* 1921–22, 1922–23,
P. F. WALKER,* 1923–24,
A. A. POTTER, 1924–25,
G. B. PEGRAM, 1925–26,
O. M. LELAND, 1926–27,
R. L. SACKETT, 1927–28,
D S. KIMBALL, 1928–29,
R. I. REES,* 1929–30,
H. S. BOARDMAN, 1930–31,
H. S. EVANS, 1931–32,
R. A. SEATON, 1932–33,
W. E. WICKENDEN, 1933–34,
C. C. WILLIAMS, 1934–35,
D. S. ANDERSON, 1935–36,
H. P. HAMMOND, 1936–37,
S. B. EARLE, 1937–38,
K. T. COMPTON, 1938–39,
O. J. FERGUSON, 1939–40,
D. B. PRENTICE, 1940–41,
A. H. WHITE, 1941–1942,
H. T. HEALD. 1942–43.
ROBERT E. DOHERTY, 1943–44.

VICE-PRESIDENTS.

SAMUEL B. CHRISTY,* GEORGE F. SWAIN,* 1893–4,
ROBERT H. THURSTON,* FRANK O. MARVIN,* 1894–5,
FRANK O. MARVIN,* CADY STALEY, 1895–6,
JOHN GALBRAITH,* JOHN M. ORDWAY, 1896–7.
THOMAS C. MENDENHALL,* HARRY W. TYLER,* 1897–8,
C. FRANK ALLEN, HENRY W. SPANGLER,* 1898–9,
ROBERT FLETCHER,* CHARLES D. MARX, 1899–1900,
THOMAS GRAY,* ALBERT KINGSBURY,* 1900–1,
STORM BULL,* CALVIN M. WOODWARD,* 1901–2,
JOHN J. FLATHER,* FRED W. McNAIR,* 1902–3.
CHARLES L. CRANDALL,* JAMES C. NAGLE, 1903–4,
CLEMENT R. JONES,* ELWOOD MEAD, 1904–5,
WILLIAM T. MAGRUDER,* JOHN P. JACKSON, 1905–6,

* Deceased.

R. C. CARPENTER,* CHARLES S. HOWE,* 1906–7,
CLARENCE A. WALDO, WILLIAM G. RAYMOND,* 1907–8,
MORTIMER E. COOLEY,* OLIN H. LANDRETH,* 1908–9,
ARTHUR N. TALBOT,* ARTHUR L. WILLISTON, 1909–10,
MILO S. KETCHUM,* WILLIAM KENT,* 1910–11,
G. C. ANTHONY,* F. B. GILBRETH,* 1911–12,
L. S. MARKS, F. W. SPERR,* 1912–13,
H. S. JACOBY, D. C. HUMPHREYS,* 1913–14,
H. H. NORRIS,* C. RUSS RICHARDS,* 1914–15,
G. R. CHATBURN,* F. H. CONSTANT, 1915–16,
HOLLIS GODFREY,* WM. M. THORNTON,* 1916–17,
JOHN F. HAYFORD,* IRA N. HOLLIS,* 1917–18,
JOHN T. FAIG, E. R. MAURER, 1918–19,
A. A. POTTER, F. P. McKIBBEN,* 1919–20,
T. U. TAYLOR,* H. S. EVANS, 1920–21,
H. J. HUGHES,* E. J. McCAUSTLAND,* 1921–22,
D. S. KIMBALL, F. G. HIGBEE, 1922–23,
H. S. BOARDMAN, O. J. FERGUSON, 1923–24,
R. S. KING, G. B. PEGRAM, 1924–25,
H. V. CARPENTER,* F. P. McKIBBEN,* 1925–26,
H. W. TYLER,* W. S. RODMAN, 1926–27,
C. E. MAGNUSSON,* THOS. E. FRENCH,* 1927–28,
C. C. WILLIAMS, G. M. BRAUNE,* 1928–29,
E. A. HITCHCOCK, ED. BENNETT, 1929–30,
C. FRANCIS HARDING,* R. A. SEATON, 1930–31,
D. S. ANDERSON, H. H. JORDAN, 1931–32,
PAUL CLOKE, H. S. ROGERS, 1932–33,
F. V. LARKIN, B. M. BRIGMAN,* 1933–34,
H. P. HAMMOND, GEO. C. SHAAD,* 1934–35,
P. H. DAGGETT, S. B. EARLE, 1935–36,
IVAN C. CRAWFORD, SADA A. HARBARGER,* 1936–37,
K. T. COMPTON, F. C. BOLTON, 1937–38,
G. W. CASE, M. L. ENGER, 1938–39,
R. W. SORENSEN, D. B. PRENTICE, 1939–40,
E. L. MORELAND, L. E. CONRAD, 1940–41,
H. T. HEALD, F. L. EIDMANN,* 1941–42.
C. E. MacQUIGG, B. M. WOODS, 1942–43,
A. R. CULLIMORE, H. J. GILKEY, 1943–44.

TREASURERS.

STORM BULL,* 1893–5,
JOHN J. FLATHER,* 1895–9,
CLARENCE A. WALDO, 1899–1902,
ARTHUR N. TALBOT,* 1902–4,
FRED. P. SPALDING,* 1904–6,
ANSON MARSTON, 1906–7,
W. O. WILEY, 1907–42,
JAS. S. THOMPSON, 1942–.

SECRETARIES.

JOHN B. JOHNSON,* 1893–5,
C. FRANK ALLEN, 1895–7,
ALBERT KINGSBURY,* 1897–9,
EDGAR MARBURG,* 1899–1900,
HENRY S. JACOBY, 1900–2,
CLARENCE A. WALDO, 1902–4,
MILO S. KETCHUM,* 1904–6,
W. T. MAGRUDER,* 1906–7,
ARTHUR L. WILLISTON, 1907–9,
HENRY H. NORRIS,* 1909–14,
F. L. BISHOP, 1914–.

ASSISTANT SECRETARIES.

L. H. HARRIS,* 1914–8,
NELL McKENRY, 1918–.

* Deceased.

ELECTIVE MEMBERS OF PREVIOUS COUNCILS.

Terms of Office Expired in 1894.

M. E. Cooley,* H. T. Eddy,* W. F. M. Goss,*
W. R. Hoag, S. W. Robinson,* H. W. Spangler,*
R. H. Thurston.*

Terms of Office Expired in 1895.

H. T. Bovey,* W. H. Burr,* O. H. Landreth,*
Mansfield Merriman,* W. G. Raymond,* G. F. Swain,*
De Volson Wood.*

Terms of Office Expired in 1896.

I. O. Baker,* Storm Bull,* S. B. Christy,*
John Galbraith,* J. B. Johnson,* F. O. Marvin,*
C. D. Marx.

Terms of Office Expired in 1897.

H. T. Eddy,* J. J. Flather,* J. P. Jackson,
Albert Kingsbury,* L. S. Randolph, S. W. Robinson,*
R. H. Thurston.*

Terms of Office Expired in 1898.

C. F. Allen, C. L. Mees,* Mansfield Merriman,*
J. M. Ordway, W. G. Raymond,* Cady Staley,
R. S. Woodward.*

Terms of Office Expired in 1899.

Arthur Beardsley,* Robert Fletcher,* John Galbraith,*
William Kent,* T. C. Mendenhall,* W. H. Schuerman,*
M. E. Wadsworth.*

Terms of Office Expired in 1900.

Storm Bull,* L. G. Carpenter,* Albert Kingsbury,
F. O. Marvin,* R. B. Owens,* R. L. Sackett,
R. H. Thurston.*

Terms of Office Expired in 1901.

T. N. Drown,* M. A. Howe, I. N. Hollis,*
Gaetano Lanza,* P. C. Ricketts,* R. G. Thomas,*
C. M. Woodward.*

Terms of Office Expired in 1902.

Brown Ayres, G. W. Bissell, J. J. Flather,*
W. T. Magruder,* F. W. McNair,* J. M. Porter,*
A. J. Wood.*

Terms of Office Expired in 1903.

C. F. Allen, D. C. Jackson, N. C. Ricker,
J. P. Brooks, Edgar Marburg,* A. L. Williston,
J. C. Nagle.

* Deceased.

Terms of Office Expired in 1904.

W. F. M. Goss,* O. H. Landreth,* Thomas Gray,* W. G. Raymond,* L. S. Randolph. D. C. Humphreys,* L. E. Reber,

Terms of Office Expired in 1905.

Wm. Esty,* H. S. Jacoby, L. J. Johnson, Elwood Mead, Edward Orton, Jr.* W. M. Towle, J. L. Van Ornum,*

Terms of Office Expired in 1906.

John Galbraith,* Frederick P. Spalding,* Charles S. Howe,* Henry W. Spangler,* Herman K. Vedder. Walter M. Riggs,* Fred. E. Turneaure,

Terms of Office Expired in 1907.

Thomas Gray,* Louis E. Reber, James C. Nagle, Arthur N. Talbot,* Arthur S. Woodward.* William G. Raymond,* Clarence A. Waldo,

Terms of Office Expired in 1908.

Victor C. Alderson, Francis C. Caldwell, Arthur H. Ford,* Henry S. Munroe,* Frederick W. Sperr.* H. P. Talbot,* A. L. Williston,

Terms of Office Expired in 1909.

Charles F. Burgess,* Arthur M. Greene, Jr., John F. Hayford,* Milo S. Ketchum,* Henry H. Norris.* Thomas W. Palmer, Joseph A. Thaler,*

Terms of Office Expired in 1910.

Fred W. Atkinson, Mortimer E. Cooley,* Walter B. Russell,* William Kent,* Harold B. Smith.* William S. Franklin,* Charles F. Scott,*

Terms of Office Expired in 1911.

L. P. Breckenridge,* Thomas Gray,* Lewis J. Johnson, W. T. Magruder,* Clarence A. Waldo. William G. Raymond,* Herman Schneider,*

Terms of Office Expired in 1912.

Frederick A. Goetze,* Frank H. Constant, H. Wade Hibbard,* John H. Leete,* Chas. Russ Richards.* Edw. R. Maurer, John C. Ostrup,

Terms of Office Expired in 1913.

C. H. Benjamin,* G. W. Bissell, E. E. Brydone-Jack, W. H. Creighton, H. W. Tyler.* John F. Hayford,* C. Russ Richards,*

Terms of Office Expired in 1914.

J. E. Boyd, C. H. Crouch,* F. L. Emory, C. E. Magnusson,* H. H. Stoek.* J. A. L. Waddell,* A. J. Wood,*

Deceased.

Terms of Office Expired in 1915.

F. L. Bishop, O. P. Hood,* W. B. Snow,*
G. R. Chatburn,* G. D. Shepardson,* J. C. Tracy,
F. P. McKibben.*

Terms of Office Expired in 1916.

John F. Hayford,* F. P. Spalding,* P. F. Walker,*
M. S. Ketchum,* A. S. Langsdorf, S. M. Woodward,
H. W. Tyler.*

Terms of Office Expired in 1917.

R. H. Fernald,* A. M. Greene, Jr., D. C. Miller,*
A. H. Fuller, E. V. Huntington, W. M. Riggs,*
V. Karapetoff.

Terms of Office Expired in 1918.

L. P. Breckenridge,* C. H. Crouch,* F. P. McKibben,*
C. L. Cory, O. P. Hood,* G. D. Shepardson,
J. B. Whitehead.

Terms of Office Expired in 1919.

A. H. Blanchard, T. E. French,* F. G. Higbee,
W. H. Browne, Jr., R. W. Gay, E. J. McCaustland,*
A. A. Potter.

Terms of Office Expired in 1920.

T. U. Taylor,* C. J. Tilden, Frank Aydelotte,
K. G. Matheson,* C. F. Scott,* W. E. Mott,
L. M. Hoskins.*

Terms of Office Expired in 1921.

Frederick Bass, O. A. Leutwiler, J. Raleigh Nelson,
C. Francis Harding,* C. R. Mann,* F. L. Pryor,
W. J. Risley.

Terms of Office Expired in 1922.

H. S. Boardman, E. F. Coddington, C. C. More,
F. C. Bolton, W. H. Kavanaugh,* E. H. Rockwell,*
W. S. Rodman.

Terms of Office Expired in 1923.

J. F. Merrill, R. S. King, L. L. Thurstone,
W. H. Timbie, J. H. Felgar, C. C. Williams,
J. C. Tracy.

Terms of Office Expired in 1924.

P. H. Daggett, M. L. Enger, O. M. Leland,
J. H. Dunlap,* J. C. L. Fish, F. E. Giesecke,
Morris Knowles.*

Terms of Office Expired in 1925.

M. W. Alexander,* H. S. Evans, H. J. Hughes,*
Edw. Bennett, E. A. Hitchcock, C. E. Magnusson,*
G. C. Shaad.*

* Deceased.

Terms of Office Expired in 1926.

D. S. Anderson, H. C. Berry, W. N. Barnard, F. A. Fish, E. J. Babcock.*, Hugh Miller, F. E. Seavey,*

Terms of Office Expired in 1927.

W. E. Brooke, G. M. Butler, H. H. Jordan, W. H. Kenerson, W. E. Wickenden. E. B. Norris, Harold Pender,

Terms of Office Expired in 1928.

G. M. Braune,* B. M. Brigman,* W. C. Hoad, J. A. Hunter,* R. I. Rees.* C. V. Mann, C. H. Mitchell,*

Terms of Office Expired in 1929.

Sada A. Harbarger,* W. K. Hatt, E. R. Hedrick,* J. J. Richey, S. M. Woodward. R. A. Seaton, J. W. Votey,*

Terms of Office Expired in 1930.

J. M. Bryant, S. B. Earle, S. S. Edmands,* H. P. Hammond, D. B. Prentice. A. C. Lanier,* C. M. McKergow,

Terms of Office Expired in 1931.

Paul Cloke, C. S. Coler, R. C. Disque, T. M. Focke, J. J. Wilmore.* H. S. Rogers, C. H. Warren,

Terms of Office Expired in 1932.

I. C. Crawford, C. R. Dooley, R. C. H. Heck, H. H. Higbie, W. H. Timbie. W. C. Huntington, N. C. Riggs,

Terms of Office Expired in 1933.

L. E. Akeley, R. E. Doherty, W. E. Farnham, Augustin Frigon, J. E. McDaniel. T. J. Hoover, F. V. Larkin,

Terms of Office Expired in 1934.

L. E. Conrad, B. G. Elliott, A. M. Dudley, A. E. Norton,* E. R. Wilcox. F. L. Eidmann,* G. A. Stetson,

Terms of Office Expired in 1935.

W. M. Cobleigh, H. B. Dirks, F. E. Johnson, Morland King, Harry Rubey. C. W. Park, A. P. Poorman,

Terms of Office Expired in 1936.

F. E. Ayer, K. T. Compton, J. B. Finnegan, W. N. Gladson, C. H. Willis. B. R. Van Leer, H. B. Walker,

* Deceased.

Terms of Office Expired in 1937.

G. P. Boomsliter,	C. E. Davies,	C. L. Eckel,
G. W. Case,	H. N. Davis,	P. T. Norton,
	W. T. Ryan.*	

Terms of Office Expired in 1938.

J. W. Barker,	A. B. Domonoske,	T. H. Morgan,
M. M. Boring,	L. E. Grinter,	S. C. Ogburn,
	F. L. Plummer.	

Terms of Office Expired in 1939.

S. W. Dudley,	H. J. Gilkey,	F. W. Marquis,
O. W. Eshbach,	E. A. Holbrook,	R. W. Morton,
	R. L. Sweigert.	

Terms of Office Expired in 1940.

G. F. Eckhard,	F. M. Feiker,	C. E. MacQuigg,
D. S. Elliott,*	S. C. Hollister,	F. B. Seely,
	A. H. White.	

Terms of Office Expired in 1941.

H. H. Armsby,	Louis Mitchell,	W. B. Plank,
H. T. Heald,	C. A. Mockmore,	J. S. Thompson,
	R. B. Wiley.	

Terms of Office Expired in 1942.

K. H. Condit,	V. M. Faires,	C. L. Kinsloe,
R. C. Ernst,	H. A. Fisher,	L. G. Straub,
	B. M. Woods.	

Terms of Office Expired in 1943.

W. O. Birk,	A. R. Cullimore,	H. A. Curtis,
H. E. Degler,	C. S. Ell,	D. P. Savant,
	G. T. Seabury.	

Terms of Office Expired in 1944.

J. H. Belknap,	A. C. Callen,	F. M. Dawson,
N. W. Dougherty,	S. Fairman,	C. J. Freund,
	R. P. Hoelscher.	

* Deceased.

CONSTITUTION.

ARTICLE I.

Name and Objects.

1. The name of this organization shall be the Society for the Promotion of Engineering Education.

2. The objects of this Society shall be the promotion of the highest ideals in the conduct of engineering education with respect to administration, curriculum, and teaching work, and the maintenance of a high professional standard among its members. The means to this end shall include educational research, the holding of meetings for the reading and the discussion of professional papers, and the publication of papers, discussions, and communications as may seem expedient.

ARTICLE II.

Membership.

Membership in the Society shall be of two general classes, Institutional and Individual.

Institutional members shall be of two classes, active and associate. The active institutional members shall be recognized institutions giving baccalaureate or equivalent degrees for curriculums in engineering, and distinguished national professional engineering societies. Associate members shall be other educational institutions giving instruction in engineering. Institutional members shall be entitled to representation at all meetings of the Society or its divisions by regularly appointed delegates, one for each institutional member concerned.

Individual membership shall be of two classes, Active and Honorary. It shall comprise those persons who occupy or have occupied responsible positions in the work of engineering instruction, engineering practitioners, and other persons interested in engineering education.

Honorary members of the Society shall be such persons as may be recommended by unanimous vote of the Council in a letter ballot to be taken by the Secretary on the recommendation of twenty members of the Society in the manner provided hereinafter for proposals for individual members. Councilors not heard from within one month from the date of mailing the ballots will be counted in favor of the candidate. Honorary members shall not have the right to vote, shall not be eligible to office, and shall not be required to pay any fees or dues.

A member in good standing may become a life member, exempt from all future payments for dues, by a single payment of an amount equal to twenty times the annual dues. Such payments received by the Society shall be placed in a separate fund known as the Life Membership Fund. The interest earned on this fund shall be used as current income.

An individual member who has been in good standing for twenty-five years or more, who has reached the age of 65 years, and who has retired from active professional life, may, upon written request, be designated as a life member by vote of the Council, and shall thereafter be exempt from the payment of dues.

The name of each candidate for active individual membership shall be proposed in writing to the Secretary by two members by whom the candidate

is personally known. The proposal shall state the qualifications on which it is based. The name of a candidate for institutional membership shall be proposed by any member familiar with the work of the institution, on receipt of an application signed by a responsible officer thereof. An affirmative letter ballot of three-fourths of those members of the Council whose votes reach the Secretary within one month from the time of sending out the name of the candidate shall elect. Such letter ballot elections, occurring before February 1, shall be credited to the previous annual meeting and dues shall date from that time; elections occurring after February 1 shall be credited to the next annual meeting and the dues for the remainder of the year shall be one-half the annual dues.

ARTICLE III.

Dues.

1. There shall be no admission fee.
2. The annual dues shall be as stated in the By-Laws.
3. Dues are payable in advance at the time of the annual convention, and become delinquent at the end of the fiscal year for which they are assessed. Dues of new members are payable at the time of election, and become delinquent at the end of the fiscal year within which the members are elected.
4. Members in arrears one year shall be retained on the roll of the Society, but shall not receive publications until such time as all arrearages are paid. Members in arrears two years, and who have been duly notified by the Secretary, shall be dropped from the roll of the Society until such arrearages are paid. The Secretary shall notify all members in arrears one month previous to the close of the fiscal year. The fiscal year shall terminate on the thirtieth day of June.

ARTICLE IV.

Officers.

There shall be a President, a First Vice President, and a Second Vice President, each to hold office for one year. There shall be a Secretary and a Treasurer, both to be appointed by the Council. In case of a vacancy in the office of President, the First Vice President shall succeed to that office. In case of a vacancy in the office of First Vice President, the Second Vice President shall succeed to that office.

ARTICLE V.

Council.

1. The Council of the Society shall consist of twenty-one elective members, one-third of whom shall retire annually, and the officers and the past presidents of the Society.
2. Any individual member of the Society shall be eligible to election to the Council, provided that not more than one elective member shall be from the faculty of any one institution.
3. The elective officers and members of the Council shall continue in office for a period of ten (10) days after their successors shall have been elected.

ARTICLE VI.

Election of Officers and Members of the Council.

1. The President, the two Vice Presidents, and one-third of the elective members of the Council shall be elected each year from the individual membership by ballot of the Society at the annual meeting.

2. There shall be a Nominating Committee consisting of the past presidents, the members of the Council retiring the following year, and one member of the Society from each Section, who shall have been elected for a term of one year at a regularly called meeting of the Section and duly certified to the Secretary of the Society before May 15. If, however, the total number of committee members attending any meeting of the Committee for official action be less than five, the President shall appoint a sufficient number to form a committee of five. The Committee shall report to the Society, at the business session provided therefor in the program, its nominations of officers for the ensuing year and of councilors for three-year terms and for any incomplete terms necessary to fill vacancies.

The senior Past President present at the opening of the committee meeting shall serve as its chairman.

Members of the Council who are serving the first year of their terms shall be invited by the Secretary to attend the meetings of the Nominating Committee as observers without voice.

By means of a form to be printed in THE JOURNAL OF ENGINEERING EDUCATION or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for officers and for the Council. These names, on the form provided, shall be sent to the Secretary of the Society not later than May 15; and, as soon thereafter as possible, the Secretary shall send the suggested names to all members of the Nominating Committee.

ARTICLE VII.

SECTIONS, BRANCHES AND DIVISIONS

1. A Section of the Society may be formed by members in two or more institutions, or by the members within a prescribed territory. A Section may be formed in any locality by a temporary organization which shall become a duly authorized section of the Society upon the approval of the Council. Sections may determine their own form of organization, but shall operate in conformity with the Constitution and the By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Sections shall be self-sustaining.

2. A Branch may be formed in any institution by a temporary organization which shall become a duly authorized Branch of the Society upon approval by the Executive Committee. Branches may determine their own form of organization, but shall operate in conformity with the Constitution and the By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Branches shall be self-sustaining.

Branches may coöperate with, or be a part of, other organizations having the same general purposes as this Society. The general purpose of Branches is to extend the interest in, and the discussion of, questions relating to the teaching of engineering students and to bring to the Society at large, through its publications, the activities in all institutions that will be serviceable to the members of the Society.

3. Papers and discussions presented before Sections or Branches shall be the property of the Society and may be published as Society proceedings if authorized by the Publication Committee. Permission to publish elsewhere may be granted by the Council on condition that the Society receives proper credit.

4. When approved by the Council, Divisions may be formed by any group of members for the consideration of questions which relate particularly to that group.

ARTICLE VIII.

Meetings.

There shall be at least one annual meeting at such time and place as the Society at the preceding meeting, or the Council, if the Society does not act, may determine. There shall be sectional and branch meetings as the members of the different sections and branches may determine.

ARTICLE IX.

Publications.

1. The formal publications of the Society shall be a monthly journal to be published from September to June, inclusive, and a year book. The *Journal* shall contain the proceedings of the annual convention, and such other pertinent papers as may be submitted to, and approved by, the Publication Committee. A bound volume of the *Journal* for each current year shall constitute the *Proceedings* of the Society.

2. Each individual member, not in arrears, shall receive the *Journal*. Each institutional member shall be furnished with two copies of the *Journal* and two copies of the *Proceedings* of the Society.

Volumes of the *Proceedings* will be sold to members who subscribe for them at a cost to be determined each year by the Executive Committee. Subscriptions for the *Proceedings* must be received in advance by the Secretary on or before October 15 of each academic year.

ARTICLE X.

Amendments.

This Constitution may be amended by a two-thirds vote of those present at any regular meeting of the Society, provided that all members have been notified of the proposed amendment by notices mailed from the Secretary's office at least 30 days prior to the regular meeting at which action is had, and provided that the amendment shall have been approved by the Council by a two-thirds vote of the members voting by letter or voice.

BY-LAWS OF THE SOCIETY AND RULES GOVERNING THE COUNCIL.

First. The officers of the Society shall constitute a committee to arrange for the annual meeting and to prepare a program for it.

Second. The President, the two Vice-Presidents, the Secretary, and the Treasurer shall constitute an Executive Committee which shall have charge of all matters relating to the expenditure of money of the Society, the making of contracts, the approval of bills, and also during the period between the meetings of the Council shall have charge of other business affairs of the Society.

Third. Expenditures of money may be made only in accordance with a definite appropriation or by direct vote of the Executive Committee.

Fourth. The annual dues shall be $5.00 for individual members, and $15.00 for institutional members.

Fifth. Reading of papers shall be limited to fifteen minutes each, or to such other time as may be designated by the Program Committee, and abstracts

of papers of about three hundred words shall be printed when practicable, and distributed in advance to the members.

Sixth. The time occupied by each person in the extemporaneous discussion of any paper shall not exceed five minutes.

Seventh. The President, the Secretary, and the retiring president shall constitute a Publication Committee, of which the Secretary shall be chairman, to edit and to have charge of the publication of the monthly *Journal.*

Eighth. The subscription price of the *Journal* shall be three dollars per year, payable in advance.

Ninth. Any educational institution which has one or more of its curriculums accredited by the Engineers' Council for Professional Development shall be considered as "recognized" within the meaning of the constitutional requirement for active institutional membership, and no other educational institution within the United States or its territorial possessions shall be so considered.

Tenth. Any engineering degree-granting educational institution in continental North America, outside of the United States, shall be considered as "recognized";

(*a*) If one or more of its engineering curriculums have been accredited by an agency whose standards are adjudged by the Council of the Society to be not lower than those of the Engineers' Council for Professional Development, or

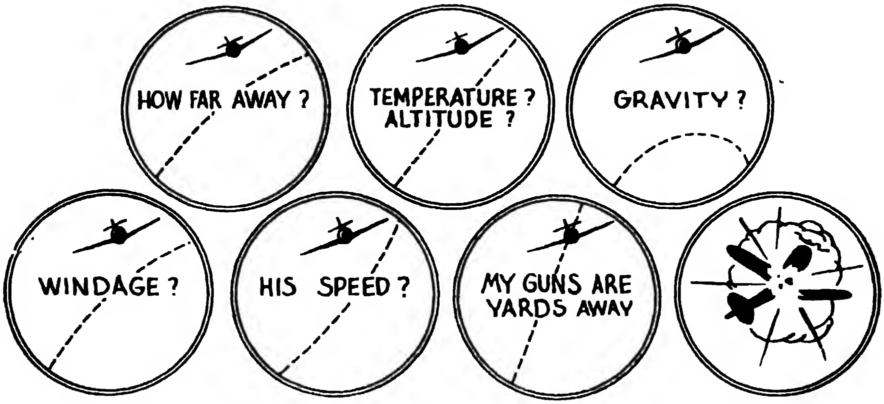
(*b*) If no suitable accrediting agency is available to appraise its engineering curriculums, but one or more of these curriculums are adjudged by the Council of the Society, upon satisfactory evidence, to meet standards not lower than those of the Engineers' Council for Professional Development.

Eleventh. Any Junior College or other educational institution giving instruction which is adjudged by the Council of the Society, upon satisfactory evidence, to be substantially equivalent to the first two years of one or more curriculums accredited by the Engineers' Council for Professional Development shall be considered as among those institutions "giving instruction in engineering" within the meaning of the constitutional requirement for associate institutional members.

Twelfth. Additions or amendments may be made to these By Laws at any regular meeting of the Society by a two-thirds affirmative vote of the membership present at the business session, provided that the additions or amendments shall have been approved by a two thirds affirmative vote of the Council membership in attendance at the meeting, and shall have been recommended by that body for adoption.

G-E Campus News

RESEARCH AND ENGINEERING KEEP GENERAL ELECTRIC YEARS AHEAD



HEAVY HEADWORK

THE B-29 has an "electric brain". And it's pretty comforting and assuring for a gunner to toss some of the heavy headwork over to it when a Jap Zero is pumping shells at him and flying as fast as he is, or faster.

The "brain", or computer, is continuously solving an equation and making a continuous adjustment of his gun's aim. There are many elements in that equation—temperature, plane speed, windage, for example. And his bullet is fired, not at the enemy plane, but at where it's going to be a fraction of a second later. The computer supplements and corrects human judgment in the factors conditioning that aim, takes over that part of the gunner's responsibility.

The "brain" has electronic tubes—plus other electrical and mechanical elements—to help with its important thinking. The corrections are relayed to the guns continuously and automatically. And the gunner is free to concentrate on the business of keeping the Jap plane framed in his sights.
General Electric Co., Schenectady 5, N.Y.

Hear the G-E radio programs: "The G-E All-girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, Monday through Friday, 6:45 p.m. EWT, CBS—The G-E House Party, Monday through Friday, 4:00 p.m. EWT, CBS

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GENERAL ELECTRIC

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"Think of the Opportunity"...

THE Chicago Bridge & Iron Company enjoys thinking they were the first to use welding on large field-erected tanks and plate metal structures. We observe one interesting feature as the number of our welded structures increases—our designs change, for the better, we believe. For instance, the elevated tank illustrated would have been entirely impractical except for welding.

Therefore, we see a growing need for engineers trained in welding design. Think of the opportunity for all our schools and colleges to teach not alone what is now done in plate metal, but also to point the way in structural steel generally.

George T. Horton

President, Chicago Bridge & Iron Co.
Chicago, Ill.

This streamlined elevated tank, built by Chicago Bridge & Iron Co., is an example of improved design made possible by welding. Its pleasing appearance is an asset to the community. And its strong, leakproof construction will save the taxpayers money.

Published through the courtesy of The Lincoln Electric Company, Cleveland 1, Ohio

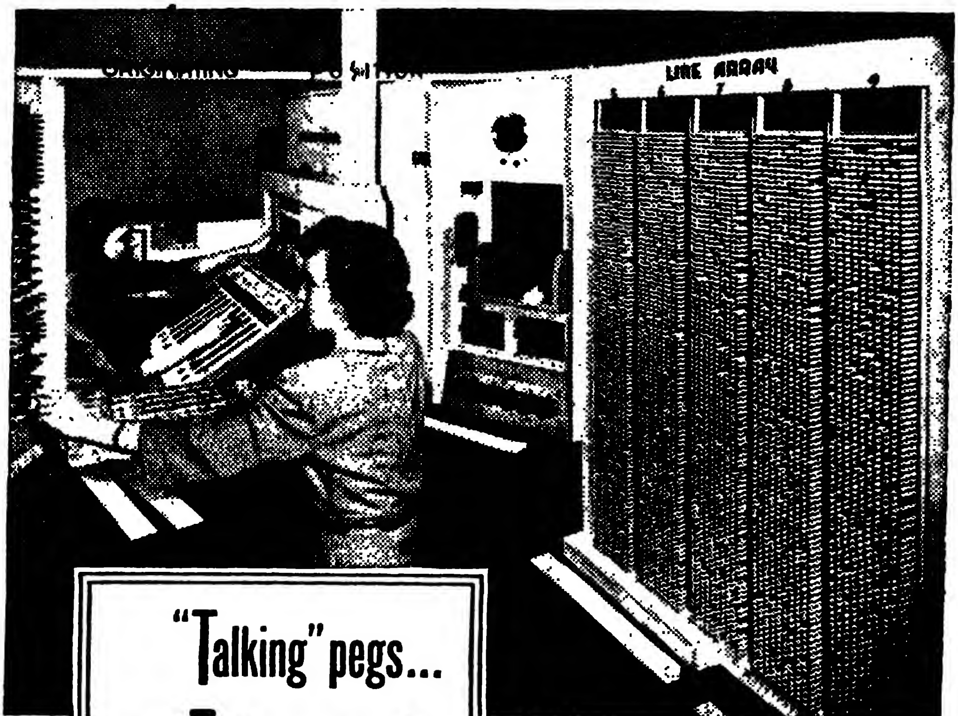
S.P.E.E.

June 1945 meeting in St. Louis

CANCELLED

The 53rd annual meeting of this Society scheduled for St. Louis, Mo., June 21–24, 1945, has been cancelled in compliance with the request of the War Committee on Conventions of the Office of Defense Transportation.

Papers, reports, and discussions, scheduled for presentation at this meeting, will be published in THE JOURNAL OF ENGINEERING EDUCATION.



"Talking" pegs... and Talking people

THERE ARE 10,000 pegs in this machine, representing 10,000 subscribers in a crossbar telephone exchange—new switching system which handles dial calls with split-second swiftness.

The pegs represent many types of telephone users—two-minute talkers and ten-minute talkers . . . people who dial accurately . . . those who make a false start or two. They are starting a journey through a unique machine which analyzes the performance of dial equipment in a typical central office.

But while an actual crossbar exchange connects your call in a matter of seconds, this counterpart moves far more slowly. It gives the Bell Laboratories engineers who built it time to observe what happens to each call—where bottlenecks develop, which parts are overworked or underworked, which of the circuits are most used.

In a manual exchange, the number of operators may be changed to meet different traffic conditions. In crossbar, all switching is done by complex electro-mechanical devices, permanently built in. This machine shows how many devices of each kind there must be in a new exchange to give you the best of service with a minimum of expensive equipment.

This traffic-study machine is one of the many ingenious research tools devised by the Laboratories as part of its continuing job—finding new ways to give you better and better telephone service.

BELL TELEPHONE LABORATORIES EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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Society Headquarters: Northwestern University, Evanston, Illinois

ANNUAL MEETING—RENSSELAER POLYTECHNIC INSTITUTE
Troy, N. Y.—June 20–24, 1949

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"A Professional Responsibility"

By K. B. McEACHRON, JR.

Chairman, Committee on Relations with Industry, ASEE; Manager of Technical Education Division, General Electric Company

The close relationship between engineering education and industry has long been recognized, but during the last few years increasing attention has been focused upon the importance of that relationship as it affects the whole engineering profession. It is but a few years ago that, at the urging of several interested members of the Society, the Committee on Relations with Industry was created.

Numbering among its membership engineers with broad interests from both industry and the colleges, the Committee has never lacked for stimulating and valuable discussions. Frequently in recent years, these discussions have led to positive action or to new formulation of policy. Such is the interest of committee members that four all-day committee meetings are held regularly each year to provide more opportunity for study and action than would be possible at the annual meeting alone.

Thus the Society, through its Committee on Relations with Industry, has extended its interest beyond engineering education alone, to the engineering profession itself, culminating in establishing as its theme for this year, "Partnership with Industry." The education of an engineer is a joint responsibility of industry and the colleges for it neither begins nor ends in the colleges or industry alone. The closer the practicing engineer and the engineering educator can work together, the more effective will be the product they create. It has been the purpose of the Committee on Relations with Industry to devote its attention to this mutual problem and its more effective solution, and also to serve as a working example of the value of college-industry teamwork.

Industrial members of the Committee have become more conscious of the opportunities they have to stimulate interest in engineering education and in the Society among their associates—an interest not limited to the football field or the basketball court. The practicing engineer is personally obligated for his own education and can most effectively "retire" that obligation by a real concern for the education of those who will succeed him. If for no other reason, he must have an appreciation and understanding of formal engineering education to provide industrial experience which will be properly integrated with such education.

Engineering educators, on the other hand, have recognized more clearly the nature of problems facing industry and the whole engineering profession. The opportunity to develop in the minds of students while still in college a sense of professional responsibility has achieved a new importance. What the colleges can best teach and what industry must be encouraged to provide has been more completely appreciated.

Out of these experiences has grown the program for the annual meeting this June. As in previous years, an afternoon discussion session has been planned to study such questions as the financial dilemma facing the colleges, the ethics of recruiting engineering graduates, and personnel evaluation in industry. In addition to this session, however, two other sessions have been planned: a Conference on Relations with Industry on Monday,

June 20, and a general session of the Society on Friday morning, June 24.

The Conference is planned to attract industrial representatives who might not otherwise attend the annual meeting. The Conference will be divided into morning and afternoon sessions. The general session in the morning will consist of talks on the three subjects of the Conference: professional development of the engineering graduate in industry, licensing for the engineering profession, and the relation of the union and the engineer. The afternoon session will consist of individual discussion groups based on the morning session. Reports of the discussion groups will be carefully studied by the Committee with a view toward preparing a statement of policy wherever feasible.

The speakers at the general session on Friday will describe the role of the individual engineer and engineering educator in industry-college relations and the factors affecting industrial activity. This session has been designed to emphasize the contribution which an individual, as distinct from an organization or institution, can make to industry-college relations and to the profession as a whole. It will therefore be of direct concern to every member.

Conferences and meetings are truly effective only as they encourage new ideas and result in positive action to implement such new thoughts. The program planned by the Committee for the June meeting has been designed to stimulate the translation of ideas into action.

. . . *theme for the year*

PARTNERSHIP WITH INDUSTRY

The Middle East and the American Engineer*

By MAX THORNBURG

Consultant on Foreign Industrial Affairs, Chairman Middle East Commission, Committee on International Relations, E.J.C.

What the American Engineer does in the Middle East during the years 1948, '49 and '50 will be an important factor in determining the fate of the world for many years to come. This can be said of *engineers*, and particularly of American engineers, for reasons that do not apply to other groups, whether military, political or commercial. It can be said of the *Middle East* for reasons that do not apply to most other great areas of the world.

The central facts upon which the truth of this depends are simple. The Middle East after centuries of stagnation under its own medievel institutions, has come to life. Its fifty million people with their vast potentials of economic power stand on the threshold of the modern world, undecided which way to turn. To the west, led by the United States, lie the nations which believe that the greatest resource of any country is its people, and that their individual freedom sets the goal towards which all state functions must be aimed. A corollary to this belief is that the individual initiative and resourcefulness of free men is the greatest source of energy that can be called upon to achieve the aims which men set for themselves on earth.

To the north lies the Soviet Union, champion of the collectivist system in which the individual as such does not count. In that system, to fulfill his duty to the State, he must dissolve himself in the amorphous institution of Communism.

In the long run, which in this case may mean within the next three or four years, it will be the people themselves who decide which model they will follow. Even though the masses of the people are slow to develop a political consciousness, their support is necessary to maintain any modern form of government in power. They may be led to believe that the best government for them is one in which authority is highly centralized and which assumes full responsibility for social and economic conditions within the country. This is the Russian idea. Or, they may be persuaded that the principal function of government is to provide certain basic institutions and services which are required by the national society as a whole, leaving it largely to the citizens as individuals to develop the social and economic resources of the country within the framework established for them by their government. This is the American idea.

To persuade them to adopt the collectivist system is the aim of the Soviet Union. This appeal to the herd instinct is primarily emotional and is powerfully effective among illiterate masses which have never known anything but poverty and oppression. Fundamentally, the impulse here is a reaction *away from* an experience of privation and suffering, rather than *towards* any clearly defined new way of life. The urge to escape poverty and oppression is innate, and the level of intelligence which characterizes the masses accepts utopian promises without submitting them to the test of reason. Conditions throughout the Middle East are favorable for this process of emotional persuasion, and can be made more favorable by inciting and intensifying social and economic disorder.

* An abridgment of a progress report prepared for the Engineer's Joint Council.

While illiteracy and a low level of reasoning are favorable to the spread of Communism, they make almost impossible the task of persuading socially and economically depressed classes that their salvation lies in the direction of individual achievement and advancement. Such a concept requires a belief in their own capacity which is contrary to centuries of experience and frustration. While dimly aware that the western peoples have accomplished the aims to which they themselves vaguely aspire, their own experience with those western powers has too often been associated with new forms of oppression rather than with relief from their existing burdens. Innovations from the west have improved the lot of those already favored by circumstances but have only widened the gap between them and the multitudes who live on the edge of starvation.

Western Techniques Must be Demonstrated in the Middle East

There is only one way in which the benefits of western advancement can be made real to the Middle East masses. That is by applying the techniques which produced that western advancement directly to the improvement of the conditions which affect the daily lives of the people themselves. No process of reasoning is required to see the value in a stream of water pouring from a new well into a field which for generations has produced a bare subsistence for a peasant and his family—or not produced it when the rains fail and the field reverts to desert. No harangue is needed to convince him that a new road is a blessing, when it makes it possible for the first time in a thousand years for his village to find a market for every pound of wheat its long wasted acres can produce. No counterappeal to his emotions will lessen the satisfaction he feels the first time he guides a steel plow across land which has never known anything but an iron-shod stick, or when he looks out over the first crop that a well cultivated field produces. If his sons find employment in the factory which makes these plows and the cultivators, farm wagons and harvesting machinery which goes with them, or in other factories which produce low-priced clothing, tools, cement, simple irrigating pumps and needed household utensils, they need no mass meeting to tell them that whatever name be given to this way of remaking their lives, it is the way they choose.

This is the way—and this is the *only* way—to argue our case in the Middle East. No high-flown phrases are necessary. No rebuttal is possible. We know this way works because it is the way America was built. We know how to do it because we built America. . . . It is too easy, and not at all true, to say that the people of the Middle East are not ready, as our westerners were, for the types of modern innovation which developed our west so rapidly. There are differences to be sure, which it is needless to recite here, but anyone who was born and raised (as the author was) on a western ranch, and who has lived with the peoples of the Middle East, sees common qualities among the peasants of Anatolia, the tribal herdsmen of central Persia and the bedowin of the Arab countries which are no different—in ways that affect this argument—from those which characterized our pioneer grandparents. The farmer's struggle with the soil and the seasons varies little from country to country or from age to age, except as better tools are put into his hands or better utilization is made of his crops. The young man's capacity to learn a trade or to tend a machine in a factory depends very little upon the language he speaks or what his father did before him. It is not on this level that the differences between East and West are important. The real difference is that the West has learned to do these things while the East has them still to learn.

How is the Middle East to learn? By demonstration, as far as the people are concerned; and it will be the *people* of the Middle East who make the decision

between our way and the Russian way—whether they know they are making it or not.

The Western Economic Record in the Middle East is Not All Good

Since World War I, which is as far back as the Middle East nations as we know them today can trace their modern histories, somewhat between a quarter and a half billion dollars (or its equivalent) has been spent there on public works and state owned industries ostensibly for the purpose of increasing production and improving the standard of living of the people. This capital investment has been sufficient, if it had been spent properly, to increase production of consumer goods to a point satisfying most of the current needs of the countries and to provide surpluses of certain goods for export. The purchasing power of the people should have been multiplied and their schools, public health services and other social needs should have been met on a rapidly rising scale. Instead, all they have to show for this vast capital investment, generally speaking, is a display of monumental public works, mostly non-earning, and of industrial establishments which produce inferior goods at costs above what better goods could be purchased for in the world market. The mass of the people themselves, living and working as they always lived and worked, neither contribute substantially to new and increased production nor create the purchasing power which would be necessary to purchase the output of the factories even if these goods were available in abundance and at reasonable prices, which they are not.

The blame for this failure to have benefitted from so vast an investment can be attributed partly to the incompetence, and in some cases the corruption of government officials, and partly to the indifference of private persons to accept their share of responsibiltiy for the national welfare. In part, however, it can be attributed to the foreign engineers and contractors who have always been ready to undertake any project which would return them a profit, whatever useless burden imposed upon the country. During the past quarter century when most of these economic programs were getting under way, the chief preoccupation of the governments was with stabilizing the new political institutions and finding the money with which to finance the new economic developments. The plans themselves had various origins but all inclined towards grandiosity, symbolizing the aspirations of these new nations rather than their current needs.

In Turkey, German technologists had for many years guided the economic development of the country, with Germany's needs for raw materials and her own strategic interests chiefly in view. In 1933, Russia came into the picture with engineering and economic as well as political specialists, under terms dictated to Turkey in connection with a loan from Russia. Both Germans and Russians promoted enterprises which provided them with the materials *they* needed or used the materials which *they* had to sell. In neither case was the Turkish national interest consulted. The nationalists who accompanied Ataturk to power confused smoking chimneys and whirring machinery with modernity and prosperity, and have only recently awakened to the fact that the people of Turkey themselves are living on almost the same level that they have known for the past thousand years. The people have awakened to this fact at the same time, and the government is now desperately put to it to correct the errors of the past fifteen years or risk the danger of a popular revolt.

In Iran the Russian interests were chiefly political and strategic, and the technical field was dominated by the German school. The late Shah was a man of tremendous vigor and rivalled Ataturk in his zeal for modern industrial establishments. He created the Industrial Bank and under its direction about 140 commercial enterprises were erected by for-

eign contractors. While the Shah sought to draw upon a wide range of foreign sources, allowing no single country to dominate the field, it was almost inevitable that a preponderance of his technical specialists would be German trained, if not German. This followed from the fact that throughout Europe, whether in Switzerland, Poland, Czechoslovakia, Sweden or elsewhere, a German technical degree was the hallmark of competence in the applied sciences. In the German technical tradition which prevailed throughout all these countries the *scientific* standard was high, but the social utility of the engineer's work was left for others to dictate.

In both Turkey and Iran, the British came in for their share of construction contracts, and some of the largest undertakings were theirs, although they took a minor part in shaping the programs as a whole. Their principal province was Iraq, over which they held the mandate, with exclusive control of both the economic development policy and the work involved in its realization. It is only fair to the British to point out that what they spent in establishing political order in this new state probably was far more than they ever took out of it in profits. Nevertheless, from the viewpoint of the engineer, it must be said that a large part of what they paid into the country as oil royalties they took out in charges for construction work which as yet has had little effect upon the standard of living of the people.

In other Arab states under the British aegis, treaties with the British have forbidden or frowned upon any but British consultants, a policy which, in the technical field, has not accelerated development. British economic and technical achievements in these countries during the past twenty-five years have been almost negligible in comparison with their great accomplishments in establishing political institutions during the same period.

In Syria and Lebanon the mandatory power was France, but despite her substantial contributions in the cultural field the record of technical and economic advancement is practically blank.

Effect of World War II

With the outbreak of World War II, German and Russian technologists vanished from the Middle East almost overnight, except those who remained for strategic purposes of their own. The same can be said of the British with the exception again of those who took part in the engineering projects which were a part of the allied war effort. The greater the artificial industrial economy which had been reared before the war, therefore, the greater the collapse when those who had kept it running withdrew. This was most noticeable in Turkey and Iran with their vast chains of foreign built factories. The false judgment which had been exercised in fixing their type and location then became visible.

During the war years, the artificial prosperity of the northern Middle East countries which resulted from foreign military activity and the demand for exports of almost every kind, enabled those unsound economies not only to live but to show superficial signs of gain. With the end of the war, however, the collapse of the spectacular superstructure of industrial plants which had no economic foundation was inevitable. Today most of the plants of the Industrial Bank of Iran, which by western standards has been bankrupt since its inception, are closed down. Some of them represent the most advanced type of installation. A foreign-built meat packing plant, for example, includes the most modern equipment for meat packing and refrigeration, and also a factory for manufacturing tin cans. Unfortunately almost no meat is raised in the region and the plant is too far from the sea to make it available for fish canning. The white tiled buildings and the costly installation are kept in a good state of preservation by the force of men and supervisors who were provided for its operation, because they are civil service employees and under the laws of the coun-

try cannot be dismissed. Their output, however, is represented by a small amount of orange marmalade which keeps the plant operating a few days each year. The region is not a fruit growing one, which makes the plant useless for fruit preservation. A competent study of possibilities would disclose whether raw products could be produced locally to supply this plant or whether it should be dismantled and reerected in another location where it would return its investment quickly.

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Certain public officials in Iran, and others there who feel a responsibility for the economic welfare of their country, have ample ground for a deep resentment towards the foreign salesmen, contractors and engineers who loaded Iran with such costly installations of so little use to the country. The same is true in Turkey. The resentment is all the more bitter because it must be suffered in silence. Whatever the feeling that the foreign experts should have protected these inexperienced governments from the folly of their own politicians, the fact remains that it was the governments themselves who ordered these plants built. Under the harsh principle of *caveat emptor* the blame is their own if what they bought proved to be useless or even worse than useless.

The same lack of responsibility towards the economic welfare of these countries that is illustrated by the sale to them of useless or ill-adapted manufacturing plants, has been even more reprehensively exhibited by some engineering firms which have been retained by those governments to make preliminary studies precisely for the purpose of avoiding such economic travesties as have just been mentioned. Some excuse may be found for foreign manufacturing concerns headed by high pressure sales executives who have no other thought than to sell to anyone who will buy. An important part has been played by this product of the American free enterprise system in America, in stimulating a demand for new and improved types of goods and maintaining a high turnover of both merchandise and money. Even in America, however, this type of executive is gradually being replaced, in the larger institutions, by men with sufficient understanding to realize that their prosperity in the long run depends upon satisfying real consumer needs and not merely upon inducing a purchaser to buy. In any case, when the service sold is professional engineering consultation, no possible excuse exists for advising government officials to spend public funds for undertakings which are not at all, or only remotely beneficial to the country.

Too many examples can be given to illustrate this apparent indifference of competent and responsible engineering firms towards the interests of their government clients in the Middle East. In one case which the author had occasion to examine in detail, a well-known engineering firm after spending about one year in field and office studies, submitted an elaborate report with recommendations, preliminary designs and estimates, which, if adopted, would have led to the expenditure of about 50 million dollars for a combined hydro-electric and irrigation water development. Review of this proposal in the field disclosed that a relatively small investment would expand an existing power plant sufficiently to meet the predicted load for years ahead, and that the small area of new land which purportedly would have been brought under cultivation by the water project was, for several reasons, unsuitable for such a purpose. It disclosed also that for a relatively small investment a series of earth filled check dams could be provided to control the seasonal flash floods which for ages had prevented more than a fractional utilization of an adjoining area many times larger than the one proposed for new development. An abundance of underground water, from 50 to 200 feet below the surface in most of this area, could be made available by the use of simple irrigating pumps. Whatever the terms

of reference under which this consulting service was performed, at least a common sense alternate to the vast scheme proposed would certainly have been in order. The dominant interest which determined the character of the report was suggested by one item in the detailed estimate, which called for the importation from northern Europe and the transportation for 600 miles by railroad and truck within the country, of every sack of cement required in the enormous concrete works proposed. This was in a country where limestone, clay and fuel abound, and cement manufacture is desperately needed for development work of every kind.

It is not suggested that private engineering firms and construction contractors should exercise a paternalistic responsibility over the decisions made by government officials, and refuse to undertake projects which have been approved for execution by the government, until they themselves are satisfied that the projects are in the public interest. When the terms of the engagement do call for an engineering opinion, however, that opinion should be given with the client's interests foremost in mind, and not with the intention of making a big job out of a little one. The aim of this general criticism is not at all to impute unethical conduct to any engineering or contracting firm, but to emphasize the importance to the government of having competent engineering guidance, free of any commercial interest in the execution of government work, to see that only well justified projects are undertaken, and that neither money nor other valuable resources are wasted in their execution.

The Middle East Has No Experienced Engineers of its Own

To understand what American engineers could mean to the Middle East, we must look at the efforts these countries are making to develop engineers of their own. For generations, it was the practice for well-to-do families to sent their sons to Europe for higher education. At one time this meant schooling in classical and cultural fields only, but as the fetish of industrialization spread over this part of the world, an increasing number of them began to study technical subjects. German universities were the most popular but many students were sent to Switzerland, France and other European countries. A few went to America. These students came chiefly from Turkey and Iran. In both these countries the technical tradition was German. This is evidenced even today by the prevalence of German text and reference books seen on the shelves of most of the older men with technical training. It is reflected also in the almost universal acceptance in Turkey and Iran of German technical standards. Of engineering in the Arab countries further south little need be said, for these countries produced few students ready for higher schooling and almost none in the technical fields.

Upon the outbreak of World War II, at the same time that the German, Russian and other foreign engineers withdrew from this region, the students from the Middle East were forced to return from Europe and turn to the United States for their training. Most of these students were sent abroad on government scholarships under contracts which obliged them to serve a certain time for the government upon their return. While the principle back of this can be defended, in practice it meant that these young engineers went to work under most unfavorable conditions. In almost no cases were they assigned to work in the field in which they had studied. Their German disciplined seniors were trained to subordinate their scientific competence to programs drawn up by politicians. The American trained engineers proved to be intractable under such arbitrary discipline. Many of them were denied eligibility to membership in the national engineering societies. During the past year, the author has talked personally with at least fifty young Turkish engineers who were graduated from well-known American engineering colleges.

Many of them held Doctor's degrees and most of the rest had Master's degrees in engineering. Practically without exception their stories were the same: "Politicians don't want engineering answers. If any answer is needed, they tell us what it is." or: "Any of us with a foreign university degree could advance rapidly if we were willing to forget that we are engineers and would simple say 'yes' to the politicians." In Iran there are said to be more than 500 engineers graduated from European or American colleges. Almost none of them are actually working at what we would consider engineering work in the United States. Of this number it might be supposed that at least 100 would be capable of doing high grade technical work. The author would estimate that not more than 10 are thus engaged in the entire country.

What these young men really need is experience under older men with the some type of basic training as their own. In the United States, this is what makes engineers out of engineering students. Obviously the Middle East's need for engineers is not going to be met simply by sending greater numbers of students to foreign countries for study, until there is an opportunity for them to get the equally important training under experienced guidance after they have taken their degrees.

What Are the Needs for American Engineers in the Middle East?

First of all among the many services which could be performed by American engineers is that of providing advisory service to the government agencies which in nearly all the Middle East countries are now struggling with national economic development plans. It is futile here to debate the theoretical merits or demerits of planned national economies or of State versus private enterprise. The fact which confronts us is that many if not most of the Middle East countries are actively pressing ahead with economic development programs in the best way they know how. In most of these cases, they are amply supplied with money, from oil revenues or other sources. The supply of men qualified for top level administration is meager, in the typical case, and most of their attention must be given to internal and external political problems and to administrative routine. It is no wonder if the relatively small number of men upon whom these burdens fall make serious errors in hurriedly prepared economic plans which cover dozens of specialized fields. If sound answers to such problems were automatically revealed to politicians or to anyone else in their moments of need, there would be little need of engineers in any country. But they are not. A modern private industrial corporation will employ a large staff of experienced specialists to prepare a single year's expansion program which both in total investment and in diversity of problems corresponds to only a fraction of a typical national development plan. Responsible government officials have even a greater need than the largest industrial corporation for consultants experienced in the various phases of such development work, to assist them in preparing and arranging for the execution of a program which will actually achieve, in appropriate steps, the objectives fixed by the national policy. Competent advisory services and assistance on this level is very likely to make the difference between success and failure of the program. Such advisory service is of course not limited to engineering, but top rank consulting engineers will know when their own services need to be supplemented by specialists in other fields.

Within the government organization itself, there is a great need for expert technical service in connection with many important State activities, such as agriculture, public sanitation, irrigation, roads, harbors, reclamation projects, geological and mineralogical surveys, statistical services and many others. In some cases, specialists in these fields can be borrowed or secured on other terms from the cor-

responding departments of our own government. While such borrowed experts ordinarily are available only for a limited time, they might be extremely valuable for detailed planning and organizational work and for training local men. Since the last war and particularly during the past year, British experts have been made available in increasing numbers from the British Middle East Center in Cairo. The author has observed the work of a number of these specialists and has been impressed with their competence and the value of their assistance to Middle East governments. The United States government has loaned some experts to Middle East countries, but few for long enough to accomplish any lasting good. An outstanding exception, although its final outcome cannot yet be known, is the staff of highway engineers recently made available to assist the Turkish government in organizing and training its own Highway Administration.

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Aside from the needs of government just discussed, there is a very large and almost totally unsatisfied demand for competent engineers in the field of private enterprise. While it is quite true that many other obstacles stand in the way of rapid development of private enterprise in most of these countries, lack of competent technical guidance is a very important one. No banker or private investor is likely to risk his capital in a cement plant, power system, irrigating project, iron foundry or other industrial enterprise, when he is dependent upon equipment salesmen and half-trained local mechanics for the analysis, design, construction and operation of a technical undertaking. The highly schooled but inexperienced graduate engineers within the country are helpless in this field until they have been trained under experienced men in making practical application of their technical education.

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There is a lack of engineering service at every level of the Middle East economy which could give direction to the bewildered effort of private enterprise and bridge the gap between its unmobilized resources and the daily needs of the people. A few branch offices of American engineering firms, each headed by a well-rounded engineer and with a small local staff drawn from the educated but inexperienced engineers of the country, could pay expenses by performing these miscellaneous services. At the same time they could select as much as they wished on larger scale for their main organizations. It is of course these larger projects which would be attractive to commercial engineering firms, but, generally speaking, the larger the project the longer the time before its benefits reach the people. The need for the lesser services, and particularly for training the young engineers of the country along sound lines, is an urgent need *now*.

Experienced contractors are needed to carry out successfully many projects which are beyond the capacity of local concerns, to demonstrate the operation and maintenance of modern construction machinery and, perhaps most of all, to train local contractors, construction superintendents, foremen and special mechanics in this field. Erection engineers and contractors, however, should not confuse their functions with those of the consultants and specialists mentioned earlier. To build a good canal, but in the wrong place, helps no one—not even the contractor in the long run.

Manufacturers of technical equipment should have competent technical representatives in the field, to advise prospective buyers concerning its value in their particular cases, to train local operators and to train competent maintenance men. . . . It has been the author's observation in many countries that, outside of a few well known lines, American equipment is known rather for its ingenuity than for its wearing qualities. In the United States where maintenance is simple and replacements with "improved models" relatively frequent, this is not a disadvantage.

British, German or other European technical equipment, generally speaking, while perhaps of obsolete design according to American standards, is likely to last much longer under the treatment it receives in backward countries. In addition to this, it is also unfortunately true that the United States has surpassed even Japan as the world's greatest exporter of cheaply made gadgets which even if given away are not worth carrying out of the bazaars which are flooded with them. All are marked "Made in U.S.A." Without doubt most of this trash is ordered by local merchants, and much of it is manufactured by American firms of foreign origin for dumping into their own home markets. Nevertheless, it is a scourge on the American name. . . .

Service of Professional Societies

The professional societies in the United States have played a very important part in improving and extending the service performed by engineers in our own country. Professional prestige has been enhanced by fixing high eligibility requirements for admission to the recognized engineering societies, and by promoting laws which limit professional practice to those possessing certain qualifications. Technical education has been furthered by the papers and discussions which are a part of the societies' programs and by close collaboration with technical colleges. Young engineers are brought into close contact with the leaders in their profession and are encouraged to participate in the activities of the societies as members of appropriate grade. Coordination of joint activities and interchange of benefits among the leading societies is effected through the Engineers Joint Council. The entire resources of these societies, representing the engineering skill of the United States, is available to the government and to the nation at large in matters affecting the public interest.

Every one of the benefits just mentioned is desperately needed in the Middle East as a means of establishing the engineering profession on its proper level in those countries. As has already been mentioned, efforts have been made to organize professional societies in certain countries, but assistance in reorganization and continued collaboration on a professional level by the American societies would be immensely valuable. The interchange of technical papers would stimulate the engineers of these countries to match the work of their American colleagues. Many valuable associations formed by engineering students in the American colleges would be preserved through the continuing association made possible by membership in the national societies.

A somewhat similar service could be rendered to the Middle East by making our high grade technical journals more readily available within those countires. Special articles and occasionally entire special numbers devoted primarily to the technical affairs of the Middle East would be justified by the commercial as well as by the professional value of such attention. The number of people in these countries who have a reading knowledge of English is surprisingly high, and is increasing rapidly. It includes most of the local engineers. Advertisements of American technical products are especially sought in the libraries and reading rooms where they are availible.

Also in the field of education, in the more formal sense, is the need of Americal collaboration in teaching engineering in the colleges and universities of the Middle East. Our American colleges and lower schools in those countries, particularly those belonging to the Near East College Association, which have trained young men, including engineers, for almost 100 years, have made a contribution to the social development of the entire region which cannot be over-estimated as to importance. It is necessary that we recognize now, however, that these institutions are no longer the "lighthouses in a sea of ignorance" which they once were. National colleges and even universities

have been established in several of these countries and their faculties include men of renown in the European countries from which they were drawn. While it probably is true that none of these national institutions has yet attained the academic level in all its faculties that characterizes the American University in Beirut, their standards are being pushed up steadily. At the same time, it is regrettably true that the American social economy under which the great system of American schools and colleges throughout the Middle East was established has undergone changes which have made it increasingly difficult to finance and administer such philanthropic establishments on a private basis. As a result, some of these institutions have not only failed to keep up with representative American educational practices, but even lag behind the rising standards of the countries themselves. It does not need to be argued that, at least in the field of advanced education, there is no place in the Middle East for a second rate American institution. This must be said with particular emphasis of engineering education, a field in which the United States unquestionably leads the world.

The steps which can be taken to make our contribution in the field of technical education involve questions which are too broad to be dealt with in this paper, and require the attention of experts just as truly as do any of the other problems in connection with engineering which have been mentioned here. It might be suggested, however, that the time has come when we should recognize that the Middle East has institutions of its own which warrant us in reviewing our whole program of educational activity in this region, and perhaps finding another way to carry our ideals and our teaching to these countries; for example by providing a few highly qualified teachers in various fields of importance, to occupy chairs in the national institutions. In any case, unless we can maintain our colleges at a level which does credit to the American name and to their own splendid histories, uninformed sentimentalism or unimplemented loyalty to a noble tradition must not be allowed to continue them merely as tombstones of their own great achievements.

It is the young men of the Middle East today who must build these new nations, and it is their own engineers who, after the initial stages, must develop their own great national resources as our engineers developed ours. During this initial stage, however, our own experienced engineers must bridge the gap; and our help is badly needed in developing an adequate supply of engineers within the countries themselves.

What Can Be Done About It?

There is no simple formula for supplying all the technical needs to which attention has been called in this paper. In the western economies, the basic technical facilities which are required by society to maintain a rising standard of public education, public health and public welfare generally, are provided largely by government agencies which are well equipped with expert and experienced personnel. Other government agencies extend the field of public services to include public works of many kinds which serve as a matrix within which private capital interests exercise the primary responsibility for national economic development. Typically, in these western economies, engineering and managerial skill follows capital interests. It seldom precedes or operates independently of them except when employed by a government agency in the discharge of its limited public functions. This is particularly true in the United States. Even in those cases such as the T.V.A., to mention a prominent example, where a government agency has undertaken a project calling for the widest range of technical and administrative capacity, it has been the skills and other resources developed under the urge of private capital interests which have performed the actual work.

That such skills and resources can be developed from other origins, for ex-

ample, from the Communism of Russia or the National Socialism of Great Britain, has been argued but has not yet been demonstrated. What concerns us here is not this argument, but the fact which faces us; namely, that the technical and managerial skills upon which the American economy depends, and which are now sought by many other countries of the world, are the product of motivations and inducement peculiar to a capitalistic economy. What we are trying to do now, with particular reference to the Middle East, is to apply them effectively to the needs of an economy in which private capital interest, with its urges and criteria of performance, is almost completely lacking. To attempt the development of private enterprise in these countries as a condition preliminary to technical advancement is impracticable. Private enterprise, as we know it, is an evolutionary growth. It may be a later product of social and economic development in these countries, but it cannot be the source of such development in the beginning.

Merely to say that the Middle East needs American technical and managerial skills is to state a futile truism. It is equally futile to invoke the "profit motive" alone—the least creative of the many motivations which make our economic system operate, by inviting western contractors to build factories or public works in these countries. The waste resulting from this course has been discussed earlier and is conspicuous in nearly every Middle East country. What we must accomplish is something completely new, except as a prototype may be found in the mobilization of our technical resources in time of war. We must dissect out of our own economic body a cross section of that part which does its constructive thinking and gives direction to the rest, and graft it into the administrative organism of the Middle East. This, of course, presupposes that the Middle East countries wish this to be done. That we shall assume. Explicitly, we must call upon the men who have built and are building our own successful enterprises in every field at home, to apply their skills and judgment to the problems of the Middle East. Fortunately, skill and judgment unlike coal or manufactured products, do not represent exhaustible assets. Knowledge can be passed on freely without diminishing the supply.

What the Middle East needs most is precisely the critical appraisal of circumstances and experienced judgment as to constructive action which our own capitalistic system depends upon and has developed to serve its own ends. In the Middle East it will serve other ends—the creation of productive economies which will enable 50 million people to enjoy those fundamental freedoms about which we have heard so much and, until very recently, done so little.

The urge to make this contribution must come largely from a sense of public duty on a world scale, although the sense of its compelling necessity, if our kind of world is to survive, will not be lacking among American technical and business leaders.

Our problem, or its solution, has two parts. First there is the need for effective preparation of the facts, a campaign for spreading information and stimulating action. In the field of engineering this is a responsibility of our professional journals and other technical publications, and of our national engineering societies. On the broader front all our publishers and editors, and all our great national business associations must do their part to awaken and inform the interest of our technical and industrial leaders. The most powerful forces in American economics are represented by such associations—manufacturing, purchasing, marketing, advertising, and the rest. They are a characteristic of our way of doing things. Their influence in mobilizing American collaboration in Middle East development problems could be enormous. They themselves are an important part of the "brain" which must be grafted into the Middle East body.

The second part of our problem is how to bring the particular institutions and individual men who must share this task, into effective relationship with the Middle East governments which constitute the sole or almost the sole sources of initiative, authority, and finance in these countries. It has been the author's experience, acting in the interests of several of the Middle East governments, that it is impossible to induce individual men of high qualification, or even individual consulting firms, to give up any substantial part of their normal work at home and assume heavy and precarious responsibilities in connection with guiding government programs of economic development in the Middle East. One practicable way in which our high-level techniques can be lifted out of their native milieu and transplanted without loss of vital functioning powers into a non-capitalistic environment, is by forming a new agency out of elements drawn from a group of qualified and established firms, in such a way that a new and powerful integration of skills is made available, without imposing an excessive burden upon any one of the several member concerns which contribute to it. The important characteristic of an agency constituted in this way is that it retains all the special functional powers developed under the exacting demands of the capitalistic system, and maintains channels to that system through which special services can be obtained as needed, but is itself free from any particular capital interest as long as it operates in isolation from that system. Such agencies were the rule in the recent war, and their effectiveness in serving non-capitalistic aims was a feature of the war economy. How long such an agency would remain virile and productive in the absence of an overwhelming public necessity, need not be debated here. The necessity for it does exist at present.

Use of American Technical Resources

A post-war example is found in the creation, at our government's request, of just such a special corporation. This new agency was formed by combining elements drawn from eleven selected engineering and other consulting firms, for the purpose of studying certain problems of economic rehabilitation in Japan. This was after an unsuccessful effort to find a solution to those problems by recourse to a "mission" composed of political and other public figures. The record shows that this specially created corporation performed its task with the same skill and thoroughness that its members' firms would exercise in their normal work for hardheaded American businessmen or private corporations.

In the case just cited it was the urge of public need which impelled the member companies to make the joint effort. Presumably the demand for special services was sufficiently flexible to keep the burden within bounds upon any one of them. In total effect, however, they brought to bear upon the technical problems of Japan the highest skill available to American industry itself, and without the urge of special interests which is customary in a capitalistic system.

Our American resources in this field are so vast that many such combined agencies might be formed, all equally capable of supplying to the Middle East the disinterested, specialized skill which finds sound answers to national problems of a technical nature. Such a consulting agency, with all its costs and fees suitably guaranteed, would enable a foreign government to map out its program by development and procedures for its execution, with the same sound judgment that must be applied to successful enterprises in the United States. With such a relatively small amount of continuing assistance in its administration at the same high level, and of training and supervision at lower levels, it would maintain a reference frame without which individual projects could not be correctly defined and oriented, and executed by government forces or by contrast in the customary way. What is lacking at present is the trained "Brain" to do the critical thinking at the top. It cannot be supplied cell by cell, in the

form of various experts scattered among the uncoordinated projects. Such experts will be necessary, but without experienced over-all management their separate technical triumphs are as likely as not to be economic travesties from the national point of view.

There is another way in which the need for top level consultation might be met. This is through a type of combined technical and management consulting firm, designed especially for giving aid to foreign governments, which has made its appearance since the end of the recent war. Unfortunately some of these new concerns represent nothing more than an effort to exploit superficial trade or service experience gained during the war, but the principal involved is capable of sound development. It is feasible, that is, for a group of experienced technical and business experts to form a consulting agency specializing in the field discussed, and to supplement their own resources by drawing upon other sources as necessary to meet any particular situation. At least one such agency is now operating successfully among Latin American governments.

It is not suggested here that all the ills of the Middle East can be cured by engineers. It is argued, however, that many of the conditions there which at present inhibit both racial and economic progress are the kinds of conditions which engineers, and particularly engineers with American training and ideas, can improve. It is argued, further, that the first and highest need for engineering, in its broadest sense, is at the level where national policy is made and where principles, objectives and criteria are established. Most Middle East governments today have neither their ranks of men nor the men to lead them who are capable of performing all the normal functions of public administration, and, on the whole, performing them well. All these governments, however, have undertaken to bring about economic revolutions with the ends, if not the means, modeled on western patterns. Their greatest single lack is for engineering skill, and this lack is greatest at the top where objectives are set and not where the concrete is poured.

Our national engineering societies have no more pressing responsibility today than to devise ways in which the faculties of American engineering can be used to remove the sources of economic distress in other countries. In the Middle East, where the strain is near the breaking point, this need must be met soon if it is to be met our way.

. . . *theme for the year*

PARTNERSHIP WITH INDUSTRY

New Horizons in Engineering Education*

By THORNDIKE SAVILLE *

Vice President of the Society and Dean, College of Engineering, New York University

During the first two years following the end of World War II, most faculties of engineering colleges were engaged in serious review of the several undergradute engineering curricula. The results in many instances led to significant changes in some of the established curricula. In observing this process at my own institution, and from oral and written discussions recounting similar undertakings elsewhere, I concluded that this situation was still fluid, and that the time was opportune to attempt to formulate specifically a type of engineering education which I had been rather sporadically and informally advocating for a number of years. While these ideas were taking shape, and being discussed with engineers engaged both in education and in active professional and industrial practice, there appeared a number of articles proposing new concepts of engineering education which were quite in harmony with or complementary to the proposals which I had in mind. It seemed clear to me that there was a widespread groping for an improved substitute or at least alternatives to the present conventional curricula. Accordingly I welcomed the invitation to address the Mechanical Engineering Division of the American Society of Engineering Education as providing a forum where I might more explicitly describe the programs which I have been advocating, and where they might be subjected to comment and criticism by engineering educators. It is my hope that opportunity may present itself for similar analyses by employers of engineering graduates.

In order to be as concise as possible I have divided this presentation into five parts: (1) The Existing Situation as it bears on the proposals to be advanced, (2) Premises upon which I have based the proposals, (3) The Proposals, (4) Arguments in support of the proposals, and (5) Conclusions.

The Existing Situation

1. Any one of the conventional four year undergraduate engineering curricula has long been asserted, and in many specific cases has been proven, to provide a satisfactory general education for a wide variety of careers.

2. Numerous surveys have shown that a substantial proportion (50 per cent or more) of engineering graduates sooner or later leave the strictly professional practice of engineering for careers which may or may not be closely related to engineering as such. A small proportion never engage in the sub-professional or professional practice of engineering.

3. While engineering educators and the employers of engineering graduates have recognized the potentialities of engineering education as a suitable and advantageous preparation for "a career and a culture," actual curriculum adaptations in general have been restricted to (a) the introduction of more non-technical (social humanistic) subjects, and (b) the lengthening of the undergraduate curriculum to 5 years providing generally for more subjects, both technical and non-technical, as prerequisites for the first (bachelor's) degree. There have

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been a few developments of four year "general" curricula, notably at Stevens Institute of Technology. Yet most of these have either a fairly strong flavor of some special branch of engineering (such as mechanical) or are more of the "administrative" type, *i.e.*, after the first 3 years a student cannot readily transfer to one of the conventional professional curricula.

4. "Broadened" four year curricula, "lengthened" five year curricula and "general" curricula usually presuppose that a student must determine upon the special engineering field for which he wishes to prepare, (a) by the beginning of his sophomore or at the latest at the beginning of his junior year, and (b) subsequently proceed by means of a quite rigid curriculum toward a designated degree. In hardly any engineering college may a student select effectively his specific professional curriculum later than two years prior to receiving his first degree.

Premises

1. That as a "way of life" or as a "career and a culture" (to use certain catch phrases prevalent in recent years) undergraduate engineering curricula are unduly rigid, fixing a student at least by his junior year (or equivalent) in a program designed for strictly professional objectives in a single field of engineering, *i.e.*, civil, mechanical, etc.

2. That for the *professional practice* of engineering, the scope of scientific and technological knowledge has become so great that adequate coverage of essentials with due regard to breadth of education requires five years for a designated bachelor's degree, *i.e.*, Bachelor of (or B.S. in) Civil, Mechanical, etc., Engineering.

3. That a broad and fundamental four year undergraduate curriculum, basically engineering in character, provides a highly desirable education for a wide variety of careers, including an adequate preparation for other professions, such as law, teaching, business, etc. Indeed the medical profession is increasingly seeking specialists in subjects for which an undergraduate engineering education would provide a superior foundation.

4. That few if any existing schemes of engineering education contain adequate flexibility to provide means whereby at an appropriate place in his undergraduate program (preferably as late as possible) a student may elect or be guided on the one hand toward a termination of his formal engineering education at the end of four years as a preparation for a wide variety of careers, or on the other hand toward further specialized training for the professional practice of engineering.

If these premises can be accepted, then certain propositions as to an ideal undergraduate curriculum may be presented.

Propositions

1. The curriculum should include as many courses as possible in science and engineering which are fundamental to all fields of engineering and which logically may be part of the education of a technically trained college graduate.

2. The curriculum should include for all who pursue it no less of the social-humanistic stem than now is recommended for professional graduates.

3. The curriculum should be uniform, or nearly so, for the first three years insofar as science and technology are concerned.

4. The fourth year should have two alternative stems, such that at the completion of one stem the student may expect to terminate his engineering training as a preparation for his future career, or upon the completion of the other stem may utilize it as an adequate foundation for his further education for the professional practice of engineering.

5. The curriculum should be such that no matter which alternative might be followed in the senior year, its completion would represent a type of education properly designated as "engineering," and properly rewarded by a single degree, Bachelor of Engineering. This is important both to assure the pedagogical in-

FIGURE 1

Professional Degree of A.E.; Ch.E.; C.E.; E.E.; M.E.; etc.
Total of 30–36 Credits. Elections from present senior and lower level graduate courses and terminal stem cc

	Terminal Stem	Professional Stem
	Bachelor of Engineering	Bachelor of Engineering
SENIOR	Total of 36 Credits 24 Credits elected from Terminal Stem Courses 12 Credits elected from Professional Stem Courses	Total of 36 Credits 26 Credits elected from Engineering and Science Courses 10 Credits elected from Terminal Stem Courses

	Technical	*Non-technical*
JUNIOR	Basic Electrical Eng'g Heat Theory Fluid Mechanics Mechanics of Materials Engineering Materials Materials Laboratory Technical Electives Total 30 Credits	Electives Military Training Social-Humanistic Studies Total 6 Credits
SOPHOMORE	Mathematics Physics Statics and Dynamics Instrumentation Total 26 Credits	Military Training or Physical Training Economics English and Speech Total 10 Credits
FRESHMAN	Mathematics Chemistry Physics Engineering Drawing Descriptive Geometry Total 27 Credits	Military Training or Physical Training English Speech Total 9 Credits

tegrity of the engineering degree and to avoid inferences as to the innate intellec-lectual capacity of those electing either of the senior year "stems."

6. Those electing the "professional," rather than the "terminal" stem of the senior year, would expect to proceed by means of a fifth year of specialized study to the first professional degree, which would be a designated degree. For reasons given later I do not favor the Master of Civil, Mechanical, etc., Engineering for this degree, but as an alternative suggest the re-establishment of the professional degree in course, *i.e.*, Civil Engineer, Mechanical Engineer, etc.

The Proposal

Acceptance of the premises and propositions heretofore presented lead to an educational program in engineering more or less as outlined on the diagram shown in Fig. 1. For simplicity it is assumed that the first three years are uniform for all students. It is believed that insofar as mathematics and the physical and engineering sciences are concerned this policy should be adhered to fairly strictly. The particular courses constituting this three-year curriculum need by no means be the same for all engineering colleges. The important factor is to have a broad fundamental three-year curriculum required for all students in a given college.

Toward the close of the junior year, each student would be required to elect one or the other of the senior year stems. This would be accomplished chiefly by the desire of the student, founded upon three years experience with an engineering curriculum and a much more mature judgment than at the beginning of his freshman or sophomore year, and by faculty counseling.

The "terminal" stem would provide many electives, most of them probably of a non-technical character, designed to prepare for the numerous careers not requiring highly specialized engineering courses or for further education for some other profession than engineering. Students electing this stem would expect to terminate their formal engineering education upon receipt of the Bachelor of Engineering degree.

The "professional" stem would be elected by those students who expected to engage in the professional practice of engineering, including research. Here also would be many electives, but of a generally scientific and engineering character. These would provide introduction to the several branches of engineering, but would necessarily omit some of the highly specialized courses increasingly crowded into the senior year in many present four year designated curricula. Students receiving the Bachelor of Engineering degree at the end of four years by this route would probably have had all of the elementary and some of the advanced courses now provided in the junior and senior years of the several designated four year curricula. They definitely would not be as highly specialized in their respective fields as now. However, it would be assumed that a majority of these students would complete their undergraduate engineering education by a fifth year, leading to a designated degree, and the recipients of this would be more broadly trained and probably more specialized than under most existing four year curricula. They would certainly be better prepared for graduate work. Moreover, there would be far greater justification for a multiplicity of specialized degrees of the less conventional types, such as in Communications, Metallurgy, Sanitary Engineering, etc. At least options in such specialties would be preceded by a broader fundamental training than now is possible.

There need be no prohibition upon election of courses in the senior year by one group which were primarily designed for the second group, depending upon the student's objectives. However, the general premise would be that those intending to terminate their engineering education in four years would elect a majority of their courses from the "terminal" stem.

Obviously it will be asked "just how would you organize such a curriculum,

Possible Uniform 3 Year Curriculum

	Non-Technical	Technical	Total
Mathematics (Anal. Geometry, Advanced Algebra, Calculus)		8	
Chemistry (Modified course for Engineers with some Physical Chemistry)		8	
Engineering Drawing and Descriptive Geometry		5	
Physics (Mechanics and Heat, 2nd Semester)		6	
Composition, Speech and Report Writing	5		
Military Science or Physical Training or Social-Humanistic Studies	4		
	9	27	36

2nd Year

	Non-Technical	Technical	Total
Mathematics (Calculus, some Differential Equations and Statistics)		8	
Physics		6	
Statics and Dynamics		6	
Instrumentation (Gages, Surveying, Shop, etc.)		6	
Economics	3		
Scientific Literature with reports and speech	3		
Military Science or Physical Training or Social-Humanistic Courses	4		
	10	26	36

3rd Year

	Non-Technical	Technical	Total
Basic Electrical Engineering with Laboratory		6	
Heat Theory		4	
Fluid Mechanics and Laboratory		5	
Mechanics of Materials		4	
Engineering Materials, with introduction to Metallurgy		3	
Materials Laboratory		1	
Electives: Any two of the following: Elementary Structures (4), Electronics (4), Geology (3), Differential Equations (3), Biology (3)		7	
Military Science or Humanities	6		
	6	30	36
Grand Total	25	83	108

Note: This is not a *recommended* curriculum. It is designed, along with the two fourth-year alternative and fifth-year civil engineering curricula, to support the argument that the *general type* of engineering education proposed in the text is feasible. Many other, and probably better, arrangements of courses and content are practicable.

4th Year Civil

	Non-Technical	Technical
A. Required of all		
Reinforced Concrete		2
Structural Design I		3
Foundations and Soils		3
Electives from Terminal Stem, including Military Science	10	

	Non-Technical	Technical
B. Electives assuming headed for 5th year in Sanitary Engineering		
Hydrology		3
Water Supply Engineering		3
Sanitary Bacteriology and Chemistry with Laboratory		6
Electives from other undergraduate engineering or scientific courses totaling		6
OR		
C. Electives assuming headed for 5th year in Structural Engineering		
Structural Design II		3
Sanitary Engineering		3
Building Construction, Codes, and Estimating		3
Electives from other undergraduate engineering or scientific courses totaling		9
Total	10	26
Grand Total		36

5th Year Civil

Technical electives totaling 30 credits, plus (if desired) thesis valued at 6 credits. Of the 30 course credits possibly 15 would be present undergraduate courses (including some from the "terminal" stem), and 15 would be courses now designated as lower level graduate courses.

Note: It would be anticipated that Civil Engineers would have six weeks or more at Summer Surveying Camp prior to receiving the Bachelor's degree.

4th Year Terminal

Electives totaling not more than 12 credits from one or more "Professional Stem" curricula, plus electives from courses shown below, making a grand total of 36 credits.

Engineering, Economics and Finance	Labor and Personnel Management
Industrial Development of the United States	Marketing
Corporate Organization and Finance	Sales
Industrial Administration and Management	Public Works Organization and Administration
Factory Planning	Social-Humanistic Studies
Accounting	Engineering Law
Statistical Methods	Foreign Trade
Motion and Time Study	Speech Seminar

what courses would form the uniform first three years, what electives would be offered in each of the senior year stems, etc?" It is equally obvious that various satisfactory combinations, or hypothetical curricula, can be prepared which will meet the objectives set forth. These will vary with circumstances affecting various colleges, and the preferences of different faculties and individuals. However, it is desirable to have something concrete to discuss, if for no other reason than to indicate that the scheme is practicable. Hence there is appended a possible 3 year uniform curriculum, with fourth and fifth years in Civil Engineering and a fourth "terminal" year. *These are illustrative only* and are presented in part to support some of the arguments which follow. Better ones can doubtless be devised.

Arguments

During the past few years, no doubt stimulated by an awareness of the complex problems arising from the war,

higher education in general, and professional education in particular, has been subjected to a "soul searching" on a scale never reached before. Within a year have appeared such significant reports as those of the President's Commission on Higher Education, The National Conference of Higher Education, and the New York State Report on a State University. The professions have likewise been concerned with the future education of their practitioners. This has been reflected in studies by professional groups (such as the notable report on Engineering Education After the War), and by an increasing number of individual articles on engineering education. These articles seem to me to indicate an increasing awareness that somehow our present more or less stereotyped undergraduate programs fail to provide much that reasonably may be desired in adequate preparation for the manifold opportunities available for which training proves advantageous primarily through the engineering disciplines.

The impact of science and technology upon our civilization has been dramatized in wartime and post war developments. As a result, whether advisedly or not, there has been a tremendous increase in the number of students enrolled in our engineering colleges. The Manpower Committee of ASEE finds that the "deficit" in engineering graduates is likely to be met by 1950, and there are some fears of a substantial "surplus" for some years thereafter.

Studies by Dean Norris of Virginia Polytechnic Institute show that of 150 presidents of large corporations (not selected because of concentration in engineering activities) the largest percentage (33.3 per cent) were engineering graduates. A canvass of 107 large industrial and business concerns by Northwestern Institute of Technology showed that requirements for engineering graduates of 1947 totalled 2703, of which 1447, or 53.5 per cent were with *field unspecified,* indicating that management was at least as much interested in general abilities and aptitudes as in specialization.

Engineering graduates are increasingly assuming managerial and administrative positions in industry and government, for which it is problematical whether certain of the conventional specialized engineering curricula form the best background. In the second place there are considerable opportunities for successful careers as teachers in secondary schools, technical institutes, and junior colleges. The inadequate training received for such positions by many thus engaged has become generally recognized, and opportunities and remuneration are often quite as good as in the practice of engineering. Through the ROTC, NROTC, etc., there are careers in the Military Services the attractiveness of which need to be better known. Many industries require salesmen for the distribution and servicing of all kinds of products where an engineering background is a distinct asset. Many other positions can be at least as satisfactorily filled by those trained in engineering as by graduates from other types of education. Foreign service in the Americas and Europe offer great opportunities and need for young engineers with imagination and courage.

The first degree engineering graduates in 1940–41 numbered about 15,000. It is estimated that in 1950 such graduates will total more than twice this number. This fact, coupled with the continued increased numbers of applicants from high schools, and the probable lack of a sufficient number of strictly technical engineering positions being available to absorb all of the engineering graduates by 1950 or 1951, leads to immediate consideration by engineering educators of a number of vitally important questions, such as:

1. What are the types of occupations, not strictly technical in character, for which an undergraduate engineering background is an asset?

2. How may we "condition" our undergraduates so that they may accept, or even prepare for, such occupations? It

is probable, for example, that large numbers of veterans with Army radio training, or "radio hams" from high school, who are studying electrical engineering and specializing in communications, are unlikely to obtain positions in industry to which they now look forward.

3. Have a number of our curricula become too highly specialized in recent years, with the result that before long graduates from them, not receiving the specialized jobs for which they are trained, will find themselves ill prepared for alternative jobs where a general engineering training would be advantageous? May this not create serious disappointment, frustration, and resentment, reflected by criticism of engineering training as such, and result in an ultimate decision by high school graduates that engineering does not provide a sufficient number of career opportunities?

4. Is there not a significant difference between undergraduate engineering education for a career on the one hand, and for professional practice on the other hand? If so, would it not be well to consider promptly the desirability of certain new concepts with respect to engineering training, and the revision of curricula to make engineering education a more satisfactory preparation for a career as well as for a profession? *

It is my feeling that the two objectives are not contradictory, but that in the light of the present and the near future enrollment in engineering colleges, certain rather profound changes in our concepts of the objectives of engineering curricula are necessary if engineering colleges are to meet adequately their proper part in education for the increasing technological bases of our national economy, well being, and safety.

* There is a question of semantics here; quibbling as to whether a "profession" is a "career" may be avoided by reference to paragraphs 2 and 3 under "Premises," which will indicate the difference in objectives which the words are intended to convey.

Engineering As Contrasted With Other Professions

I am not unaware that the "stratified" type of education exemplified by engineering and medicine is presently dominant in this country; that the conventional liberal arts education is increasingly on the defensive and is slowly conforming more to the engineering type; that "broadening" of engineering curricula has been achieved by inclusion of a greater percentage of the "socio-humanistic stem" in these curricula; and that a slight increase in 5 year undergraduate curricula is observable. These factors should not obscure the different approach to engineering education which I am proposing.

For many years it has seemed to me that engineering education has been inferior to that for the other professions by an undue specialization, continuously accelerated, in the four undergraduate years. In my opinion this situation is not best remedied either by a required two year liberal arts course preceding technological studies, nor by 5 year undergraduate curricula in the several fields of engineering. Both, it seems to me, miss the dual objectives of career and professional training, and increasingly tend to prolong unduly the educational programs of too many of our students. As the late Dr. Wickenden quotes Stephen Leacock: "education is eating up life." The suggestion from a committee of one of the largest engineering societies, urging the post-graduate training of larger numbers as a partial remedy for any threatened over-supply of engineering graduates, does not seem to me a logical solution to the problem. We need a "specialist corps" of highly trained engineers as the backbone of the profession, and post-graduate training for these will be increasingly essential. This should be provided for a selected group and as a requirement for the highest echelons of strictly professional practice, not as a cure for any overcrowding of the profession.

The majority of engineering students are concerned with a career, and more often than not specialized engineering post-graduate study is not a requirement, and perhaps not even desirable, for this. Furthermore, with the exhaustion of G.I. benefits, the total cost of an adequate college education will become increasingly of concern to many students.

The term "specialist corps" of the profession should not be misconstrued. I think many engineers and the public generally need to appreciate better the distinction between engineering as a preparation for a profession demanding constantly increasing scientific and technological training, and preparation for a career for which a general undergraduate engineering backbone is highly desirable. The latter requires no less ability and mentality than the former, but each may require quite different aptitudes and interests. Preparation for leadership in business and public affairs is no less important and necessary than preparation for a technical profession. Indeed as engineering trained men more and more are looked to for positions of great trust and responsibility in the direction of managerial activities in industry, business and government, and in international affairs, there is a peculiar obligation upon engineering educators to face squarely the challenge to consider alternatives to the conventional training of the past, to contemplate bold experimentation looking toward new types of engineering education as perhaps important elements in the ultimate progress and security of our country. There are grave psychological factors to be overcome, both on the part of faculty and of students. The problem far transcends that of mere curriculum juggling or of expedients looking toward outlets for an increased number of engineering students.

Advantages of Proposed Curriculum

One solution to the problems posed herein, would, I believe, be the establishment of the type of four year curriculum proposed in the preceding portions of this article, involving a dual stem for the senior year. At least 50 per cent of the seniors, completing their work for the Bachelor of Engineering, would be prepared through judicious choice of senior electives to pursue a variety of careers as contrasted to strictly professional objectives. They would be better prepared for managerial posts even in industry and government than many of our present graduates, as they would be also for the types of non-engineering careers previously mentioned. They could pursue graduate work in many other fields for which their aptitudes and desires had developed.

The remainder, headed for strictly professional goals, prepared by senior year electives, would take a 5th year for the designated degrees. Not only would they be better prepared than now for the first technological positions, but they would be more broadly educated as professional men and citizens. Furthermore, the wide choice of electives in the fourth and fifth years would give greatly increased scope for imagination, developing talents and aptitudes, and new aims at a time when maturing viewpoints permitted a far wiser selection of objectives than is possible in the freshman and sophomore years.

A corollary would be the restoration of the Master's degree upon a really post-graduate level. Due to the increase in important engineering and scientific specialities, impossible to crowd into many of the presently highly specialized undergraduate curricula, the Master's degree has increasingly become merely a fifth engineering year in which there is time to pick up specialized courses, desirable for a specialized job. Advanced scholarship and research have declined.

Community College Trend

There is a corollary to the arguments advanced for the type of programs suggested. This stems out of most of the reports on higher educations previously referred to. All advance strong recommendations for the establishment of

"Community colleges," and suggest greatly expanded public aid to remove financial handicaps from those adequately qualified to benefit substantially from a college education. Large increases in college enrollments are generally forecast.

The establishment of many more "community" or junior colleges seems to me inevitable. The adoption of an engineering program similar to that advanced herein would have significant relations to this trend toward local two year colleges. All or nearly all of the first two years of the "general" Engineering curriculum could readily be achieved in such colleges, and in many liberal arts colleges. In some instances a single summer to pick up a few strictly technological subjects might be necessary at first. But generally speaking a trend already stimulated by the pressures of veterans' education will continue, and more and more both economic and intellectual factors will accentuate this trend. It will be possible to reduce the size of our freshman and sophomore classes where mortality has long been almost scandalous, and to provide better qualified upper class students. Total enrollment in engineering colleges could even remain nearly as large as at present, but there might easily be more upper class than lower class students, providing a more sound professional and financial basis for a superior engineering faculty. There are many other advantages from a system of this sort, which I am sure will be readily apparent to many who read this.

There is no doubt that many of the ideas advanced herein have occurred to and in specific parts been advanced by others. For example Dean Eshbach of Northwestern University in an address on "Two Hundred Years of Engineering Education" published in *The American Engineer* for June 1947 stated, "would it be more useful to young engineers and the industries they serve if almost no specialization beyond that of basic engineering instruction were attempted in the undergraduate program? A five year program as now advocated by some could then lead to a degree of B.S. in engineering in four years and an M.S. in engineering in the fifth or sixth year." I could quote many excerpts from recent articles by practicing engineers and by engineering educators which would support many of the arguments which I have presented. If there is any novelty in the proposals made here, it is in concrete suggestions for a new type undergraduate curriculum which attempts to synthesize many diverse ideas previously advanced from many different viewpoints. The writer has been greatly assisted in this presentation by critical review of the curriculum proposals by the departmental chairmen at the College of Engineering of New York University, and by extended discussions with Dean M. P. O'Brien of the University of California at Berkeley, who quite independently had reached certain of the conclusions advanced herein.

Conclusions

A four year undergraduate program is desirable and can be designed to prepare satisfactorily for a large number of careers, including those involving the professional practice of engineering. Adequate recognition is not given in most of the conventional curricula traditionally pursued heretofore to the dual objectives of undergraduate engineering education. These can be achieved by an initial three years substantially uniform in character for all students, followed by a fourth year designed with two main "stems," but permitting sufficient flexibility between each so that the first degree of Bachelor of Engineering may be awarded.

One senior year stem (called the "career" stem) would be designed to provide terminal engineering education. To this would be directed that large number of students who are benefited by a broad engineering education as a preferable background for ultimate managerial or supervisory or sales and promotion positions in industry or business, for careers in the military services, for teach-

ing positions in secondary schools and technical institutes, for postgraduate work in business or other professions, and the like. This stem would provide a wide choice of electives, generally of a non-technical character. It might well present an array including more economics, history, public relations, labor and management problems, marketing, statistical analysis, and the like. The graduates from this stem would come to look upon engineering education as a desirable preparation for a wide variety of careers.

The alternative senior stem (called the "professional" stem) would be equally large in possible electives, but these would be mostly of a technical character, preparing for the several branches of the engineering profession, and generally entered into with the intention of taking a fifth year at the end of which a designated engineering degree would be given.

Many of those completing the "professional" stem and the fifth year would continue as graduate students for the Master's and Doctor's degrees. They would be those whose abilities and aptitudes fitted them for the more highly mathematical and scientific phases of engineering. These, on both the undergraduate and graduate level, are called the "professional" group as compared with those who, while equally gifted intellectually, found their abilities and aptitudes leading toward careers which, even if engineering in nature, were not of a highly professional character.

Such a curriculum would seem to make engineering education a real preparation for life and service. It would meet the needs of many young men earnestly convinced that engineering studies can best prepare them for their future careers, but having aptitudes and abilities which, though superior in many respects, are not such as to be successful in the increasingly mathematically rigorous and specialized subjects required for professional practice in the several branches of engineering. It would meet many of the criticisms leveled at engineering education by employers who for many of their positions wish engineering graduates more diversely trained than is possible under existing rigid curricula. The flexibility of the proposed program would permit engineering students to defer a decision as to ultimate objectives until they are more mature, experienced, and better informed than is possible under present practices. The program also permits the first two years to be pursued in community or junior colleges with subsequent transfer to an engineering college, with resultant economic and social advantages.

The proposals are aimed primarily at making an engineering education more flexible in prosecution to the end that it may better serve greater numbers of students engaged in higher education, and may better prepare them for a greater number of careers other than the professional practice of engineering. With respect to the latter, the proposed programs are designed to provide better fundamental preparation in the basic scientific and engineering specialties, and an improved procedure for those whose aptitudes and abilities lead them to prepare for graduate work and research.

Post-War Engineering Enrollment Rapidly Adjusting to Near Pre-War Level

By S. C. HOLLISTER

Dean, College of Engineering, Cornell University

In recent months many statements have appeared in the public press to the effect that the rate of training of engineers is far beyond the demand, and that unless some means of reducing the number of graduates coming from the engineering schools is invoked, the prospects for many young engineers of finding suitable employment in the profession will be poor indeed. It is no wonder, therefore, that many well qualified boys soon to graduate from high school are in a quandry as to whether they should perhaps shift to another field lest upon graduation they may find no employment in engineering. Parents are also beginning to question the wisdom of encouraging preparation for engineering training in the face of the adverse publicity appearing frequently.

Since the most reliable information I can obtain does not bear out the statements being made, it seems desirable to place the results of a study of the situation in the hands of engineering educators for their use in counseling young men concerning the outlook in the profession.

The annual publication of enrollment data in the JOURNAL OF ENGINEERING EDUCATION, together with data on secondary school graduations from the United States Office of Education, has been the source of the study. The interpretation of these data is my own. Freshman enrollment during the war years was limited to civilians. In some pre-war years not all schools reported the data sought; hence in these cases the figures were adjusted to estimate the total enrollment of all engineering schools.

Diagram 1 shows freshman enrollments in engineering in American and Canadian schools, for the first term in each year from 1930 to date. Short dashes indicate estimates. The lag caused by the depression of 1931-5 is clearly shown. Similarly, the effect of Selective Service operation during the War shows a reduction in freshman enrollment. After 1945, stimulated by the benefits under the so-called G.I. Bill, the enrollment shot upward to more than double that of any previous year.

On the same diagram is shown a curve of graduations, the numbers plotted in each instance being the total for the preceding year. Thus for the year 1939–40 there is shown a total of about 13,000 who graduated during the academic year 1938–39.

In order that a forecast of graduations may be made intelligently, it is necessary to consider the interrelation of the graduation and freshman curves. In the fall of 1936 nearly 30,000 freshmen were enrolled (point p). In the following autumn the same class, now sophomores, numbered about 24,000; and eventually, during 1939–40, there were graduated from the class about 17,500 (plotted at 1940–41 at r). The line p–r thus represents the progress of the class from the freshman year to graduation. Other classes before and since the War are similarly plotted.

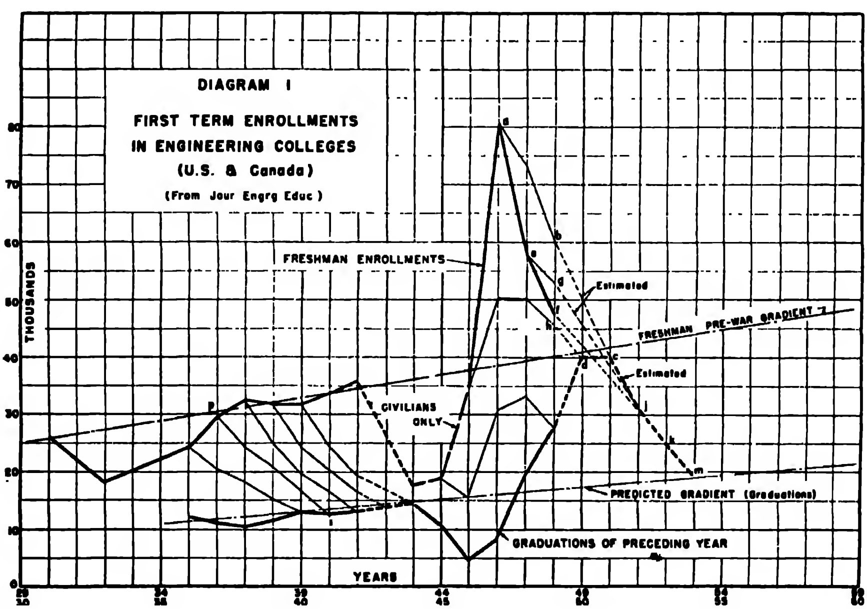
We may now consider the progress of the large freshman class of 1946 (point a). Last fall this class, now juniors, had decreased from over 80,000 to about 60,000 (point b). It is estimated that 40,000 will be graduated during 1949–50 (plotted at c). Similarly, the freshman class of 1947 (point e), now sophomores (point g), will yield about 31,000 graduates (point j) from the original 57,000. The class entering in 1948 (point f) will drop from 47,000 to 25,000 (point k) at graduation.

It is interesting to note that with decline of veterans in freshman enrollment the entering classes have decreased from over 80,000 in 1946 to 47,000 in 1948. This is only 7000 above the freshman gradient of pre-war years, indicating a rapid adjustment back to this line, which is related to the steady indicated growth of the profession before the War.

During the present academic year (1948–49) it is estimated that 40,000 engineers will be graduated. Half of these graduated from college at mid-year; and the indications are that they were absorbed at a rate somewhat above normal. Next year will see a similar number graduate, after which the numbers will rapidly decline in reflection of the rapid decline that has already taken place in freshman enrollment. By 1952–53 it is anticipated that graduations will reach the normal gradient extended from pre-war years (point m).

The problem of absorption of engineering graduates, if there be one, will develop next year or the year after. In this connection, it should be noticed that the large numbers graduating this year and next are in considerable part replacements for the large deficits in engineering graduations during the war years, a fact which has been borne out by the acute shortage of engineers following the War. Beyond 1951–52, the numbers graduating will approach the pre-war norm. In any case, the freshman entering in 1949 is not likely to find placement difficult upon graduation for or five years later, unless a severe economic depression develops.

What lies ahead with respect to graduation trends? As seniors derive from freshmen, so the latter stem from graduating classes of the secondary schools.



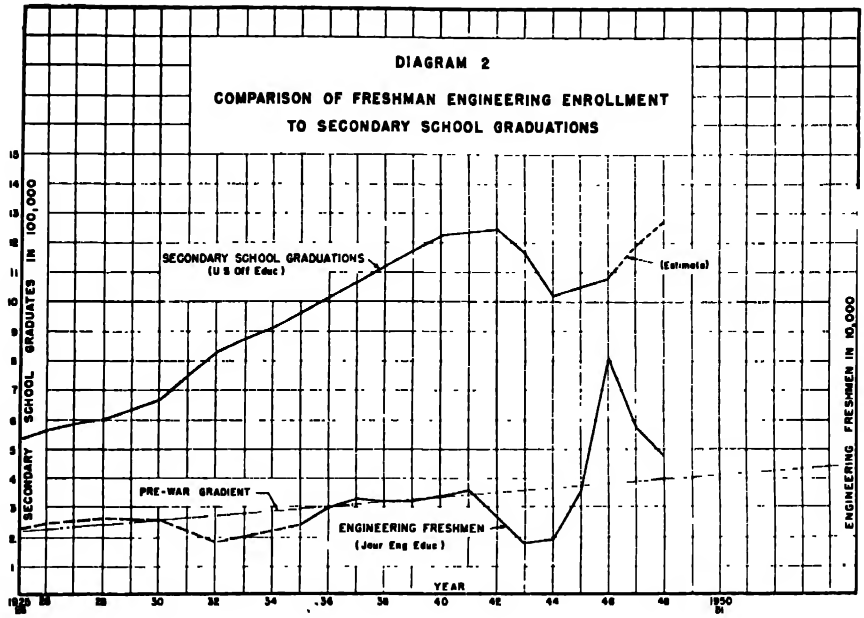


Diagram 2 has been prepared to show what may be expected of freshman classes. The curve of graduations from high schools shows a steady upward trend, which if continued would reach approximately 1,600,000 this year. Beginning in 1940, however, the rate of graduations were off over a quarter of a million. Since then the trend is again upward, but still about a third of a million less than the number indicated by the former trend will be graduating this year. This is approximately the result of the decline in birth rate noted during the 1930's.

The effect of the break in numbers graduating from high school will be to hold the freshman engineering enrollment in accord with the pre-war gradient, or perhaps even to depress it somewhat. This situation is not likely to change until the effect of the wartime rise in birth rate is felt—sometime after 1960. Until then, there is no indication presently discernible to suggest an appreciable rise above the pre-war normal gradient. With stable economic conditions, the prospect for employment in engineering should be good. No student of real ability and strong aptitude need worry in any case. Such men are never in oversupply.

It may be well to point out in conclusion that this study has been limited to an analysis of the data affecting enrollment and graduations in engineering, with the object of indicating the apparent return to a normal pre-war pattern. If the discussion is extended to predictions of demand for engineering graduates, it is possible to point to a number of factors such as the far-reaching scientific and technological advances of the past few years, the use of engineering graduates outside the profession, the engineering problems of our diminishing resources—all of these and many others that may cause a sharp upward trend in engineering employment. It is conceivable, therefore, that a rapid development of these factors, or the development of a national emergency, might actually find us in short supply in the next decade.

The Role of the Technical Institute in American Education*

By LAWRENCE L. JARVIE

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Representatives of industry, education and others since before the turn of the century have recognized that there was a lack in our system of education. As our secondary schools, colleges, and universities expanded, a feeling developed that there was need for the inclusion of two year schools immediately beyond high school. To meet this need two types of institutions emerged slowly over the first three decades. One was the junior college, primarily preparatory in purpose and influenced by the upper division of colleges and universities; the other, the technical institute, primarily terminal in purpose and influenced by the demands of a technological society. As late as 1931 there were those who believed these two types of schools in our system of education could never merge since their purposes were dissimilar. This is evidenced in the following quotation from "A Study of Technical Institutes" sponsored by The Society for the Promotion of Engineering Education:

> "There is no basis in experience for expecting the junior college of a mixed character to do the work of a technical institute successfully."

Within the junior college movement there were in turn many persons who were of the opinion that the ends sought by technical institutes could never become one with the aims of the junior college. At that point it appeared that two new institutional types were to evolve to meet the need for two year institutions immediately beyond the high school. Various groups admitted that a great expansion was necessary for two year post-high school institutions. The problem was what form these institutions should take.

Junior Colleges and Technical Institutes

As frequently happens in the early stages of evolution, the differences between the junior colleges and the technical institutes were not as great as appeared on the surface. As junior colleges expanded they found that the goal of college preparation was meaningless for the large majority of their students. Graduation meant the end of formal education. Graduates found themselves in a society in which they were forced to become economically productive. Concurrently, industry was recognizing the increasing necessity for personnel trained for technician jobs. Faced with the facts of being largely terminal institutions and the demands of a technological society, junior colleges reorganized curriculums to include courses basically related to general and specific occupational fields. More and more the junior college in recent years began to take on the hue of technical institutes.

Meanwhile technical institutes became sensitive to the fact that human beings function beyond the sole sphere of earning a living. The purposes of technical institutes broadened as public funds were made available, since public schools must be justified in terms of contributions to

* Presented at the General Session of the Annual Meeting, Austin, Texas, June 15, 1948.

society which are broader than occupation alone. Industry in turn was becoming concerned with the need for personnel prepared broadly and beyond the scope of the job alone. Increasing concern was felt for providing students with knowledge and experiences essential for the formation of a foundation from which to grow and develop beyond their jobs. More general courses were introduced to the curriculums of technical institutes. As a result junior colleges and technical institutes recently began to look very much alike. Instead of two separate types of two year college institutions arising to meet the need for a new type college a single form of institution was emerging. The most common title being given to this new college is that of community college.

Planning for Higher Education

The need for this new type college, whether it be called junior college, technical institute, or community college, is being recognized on a broader scale daily. In 1944 the Educational Policies Commission of the National Education Association issued a prophetic book entitled "Education for All American Youth," and the National Association of Secondary School Principals brought out a pictorial companion bulletin "Planning for American Youth." In them appeared a vision of Community Institutes in every American Community, offering two years of general and technical college education to high school graduates, and many other kinds of education to other adults. In that year also the Board of Regents of the State of New York published their plan for Post War Education calling for the expansion of six existing Agricultural and Technical Institutes and the long range addition of new, two year Institutes of Applied Arts and Sciences. Illinois was discussing the prospective need for ninety publicly controlled junior colleges. Texas was considering proposals for one hundred junior colleges.

More recently the President's Commission on Higher Education suggests a broad expansion of community colleges emphasizing programs of terminal education aimed at developing a combination of social understanding and technical competence. The New York State Temporary Commission on the Need for a State University recommends the establishment of two year Community Colleges offering a combination of technical and general education. And so it goes. It would appear that a major lack in our system of education felt by a few approximately fifty years ago is in the process of being rapidly corrected.

While a new type of college is evolving which combines the best features of the junior college and the technical institute, it does not follow that the pattern of curriculum content is firm. At the moment the drive toward community colleges comes primarily from a desire to provide expanded educational opportunity for youth beyond high school at low cost to the student. Because of this pressure it is imperative that the approach to curriculum be highly experimental. Thinking must go beyond the placing of bodies in simply another school. There must be broad consideration given to defining the purpose of the new type college and concurrently all persons now administering junior college and technical institute programs need to be examining their present reasons for being. In New York State the Board of Regents has defined the purpose of these schools to include:

1. A basic preparation for selected arts, technologies, and sub-professions which require a technical proficiency not reached in high school programs.
2. Related offerings in arts and sciences.
3. Personal and civic arts designed to further the general welfare and understanding of the students.

Motives of Instruction

As the above purposes are considered, it is necessary to recognize that the basic

motivation for instruction is derived from the concept of preparing individuals for technical positions in various types of industry. Granting that such motivation appears highly materialistic, it does not follow that there can be no concern with experiences which enable the student to live beyond a job. What is required are curriculums which synthesize the needs of society for an educational program to help young men and women make positive contributions as citizens and workers.

A curriculum pattern must be sought which recognizes the interrelationship of experiences in the growth and development of individuals. Courses must be organized upon the basis of a single end, and experiences within one field of knowledge must be coordinated with those of all fields in which the student studies. Experiences must have relevancy to the daily and far-reaching problems of effective and satisfactory living. Emphasis must be placed upon practical application and interpretation of knowledge and experience. In this manner the student is aided in developing a foundation upon which to build a comprehensive understanding of citizenship in action. At the same time he will achieve mastery of certain skills and knowledge essential to beginning job competency in particular technical fields.

Technical preparation must, however, go beyond specific skills to the achievement of a broad base of technical understanding within the technology of a specific industry. This is in contrast to the engineering college which is concerned with the whole science of a particular field of human knowledge with incidental regard for a specific industry. A contrast exists also between the technical institute, or community college, and the trade school; the latter having as one of its purposes the mastery of specific skills in a particular trade. Technical preparation within technical institutes seeks a level between trades and professions.

New York State Study

Whether or not one agrees with the point of view herein expressed, an analytic and research approach must be made in the creation and expansion of technical institutes and community colleges. Recently five Institutes of Applied Arts and Sciences have been established in the State of New York. A number of these institutions were recommended by the Board of Regents in 1944. Legislation created them as state schools in 1946. During the intervening years between recommendation and action an extensive research program was carried forward in order to determine the actual need for such two year colleges and what curriculums should be included. The following questions constituted the base for the research:

1. What are the opportunities for employment in technician positions?
2. What curriculums would be necessary to prepare persons for the technician jobs available?
3. How many students might be expected to enroll in these institutions?
4. In what geographical areas should each curriculum be offered?
5. What would be the cost of an adequate program?

The above questions led to an extensive survey of the job structure of New York State industries. Some 325 technician type jobs were identified which met the criteria below:

1. Emphasizes technical knowledge.
2. Emphasizes technical skill (the ability to use technical knowledge).
3. Deals with rational processes as contrasted with empirical rules.
4. Has concern with cause and effect.
5. Emphasizes analysis and diagnosis.
6. Requires frequent exercise of ability and judgment.
7. Deals with many factors and a large number of variables.
8. Contends with a large variety of situations.

9. Requires a knowledge of skilled work but not necessarily skill in doing it.
10. Requires a broad background of fundamental science and mathematics.
11. Involves use of a variety of instruments.
12. Requires effective use of language to interpret orders and make reports.
13. Involves the element of leadership in supervisory occupations.
14. Requires understanding of industrial equipment and processes.
15. Frequently involves visualization of plans and drawings, and a degree of creative design.

Approximately 10 per cent of all persons employed classified into the 325 technician type jobs. Within this group the annual replacement rate was found to be 5 per cent. This means then that the industries of the State require upward of 25,000 technician replacements each year.

By the analysis of technician jobs it was established that 22 curriculum areas would have to be explored in order to provide preparation for some 86 per cent of annual replacement requirements. With job opportunity and curriculum type identified the next question concerned the student potential that might be available for a system of institutes or community colleges. In 1939–40 there were 65,000 high school graduates in New York State who did not continue their formal education. An assumption was made that due to the regional nature of the institute system 20 per cent of the above might enroll. This meant an annual potential of approximately 13,000 first year students. With a carryover of 60 per cent of first year students, a theoretical potential existed of about 21,000 students at any given time. Annually then there would be some 10,000 graduates being fed into the man-power pipeline to meet an annual replacement demand of 25,000 technicians. It is apparent then that even with a broad institute program the labor market would not be oversupplied.

A statewide student potential is one thing and the distribution of that potential is another. When geographical studies were made with respect to job opportunities and student distribution there were areas that could not support an institution on either score. Here is found an important factor that must be considered in the expansion of community colleges. Otherwise there is danger of small weak schools developing which are of little value to their communities and students.

Financing Technical Institutes

Throughout the study the matter of cost was not ignored. Estimates with respect to the annual operating cost of a program enrolling 21,000 full time students ran slightly over $10,000,000. In view of this it was decided to make estimates for an experiment involving five schools with an over-all enrollment of 4,500 full time students in rented or loaned buildings. With slightly over one year's operation these estimates vary somewhat from actual cost as shown below.

	Annual Rental	Equipment and Reconversion (non-recurring)	Operating Cost (annual)	Total
Estimated	$325,000	$2,500,000	$1,875,000	$4,700,000
Actual	175,000	2,300,000[1]	1,850,000[2]	4,325,000

[1] Supplemented with war surplus equipment having a replacement value of upward of $1,500,000.

[2] Estimated since full enrollment of 4,500 will not be reached until September, 1948.

The type of research summarized here must be carried on in the development of broad programs of public community colleges and technical institutes. Similar research can be carried on by local and private technical institutes as they develop new curriculums.

Curriculums Offered

Within the five new Institutes of Applied Arts and Sciences this early research made possible the identification of the curriculums to be set up in each school. At the present time these curriculums are: Dental Laboratory Technology, Metallurgical Technology, Electrical Technology, Chemical Technology, Retail Business Management, Mechanical Technology, Hotel Technology, Commercial and Industrial Design, Building Construction, Dental Hygiene, and Food Technology. No one institution offers all of these curriculums. Each curriculum is viewed wholly as experimental and content changes frequently. All are being studied with aid of local advisory groups for each field. Membership of these committees is derived from industry, labor, other schools and the public at large. At this point it may be said that members of engineering faculties in several universities have been invaluable as committee participants. The result is that there is no evidence of conflict between the engineering schools and the institutes.

From the presentation so far it should be apparent that in New York State an attempt is being made to move from philosophy to action in establishing the role of the technical institute in American education. Whether or not the attempt is succeeding is for others to judge. Many things remain to be done in the years ahead and one of these is the matter of preparing instructors for these new institutions. Here engineering colleges and to some extent industry can make an outstanding contribution. There is at the moment a monograph in preparation by the American Council on Education which makes a case for the need of 30,000 instructors for technical institutes and community colleges by 1960. Many of these instructors must come from colleges of engineering and others from industry. They cannot be prepared in teachers colleges. However, to meet this new market engineering schools must think in broader terms than simply the education of engineers. Technical and professional schools need to recognize the fact that the field of teaching offers important occupational opportunity to their graduates, and then develop programs in cooperation with other schools within a university which will produce graduates who are teachers as well as engineers, chemists, or retailers.

Time does not permit exploration of the many other contributions which engineering colleges can make to the evolution of the technical institute idea. The exact role of the technical institute or community college in American education has not yet been defined. Definitions to date have been general in terms of function and purpose. There is widespread agreement that they are needed; that they should function at the college level; that they should develop two year terminal programs; that they should be occupationally directed toward the technician level of industry; that they should be community centered; and that they should provide students with knowledge and experience beyond just the vocational aspects of life. All of this gives direction, but there is need to move toward the specifics of action. What should go on from day to day in these institutions is not clearly established. Experimentation must go on constantly and in the years ahead the technical institute idea will achieve its own integrity within our system of education. The role of the technical institutes and community colleges in American education at the moment is that of pioneering a new frontier in education, a role made possible for public institutions by the pioneering of hardy individuals and private institutions over a long period of years.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NOMINATION BLANK

"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

I nominate the following members of the Society for officers:

For President ....

....

For Vice-President ....
(2 years)

....

For Treasurer ....

....

Signed ....

Title ....

Institution ....

Date ....

The above nomination blank must be returned before April 19, 1949 to the Secretary, A. B. Bronwell, Northwestern University, Evanston, Illinois.

Report of Committee on Ethics of Interviewing Procedures*

FOREWORD

In order to formulate a broad general code of ethics of interviewing procedures, the American Society for Engineering Education appointed a Committee on Ethics of Interviewing Procedures. It was felt that such a code of ethics has been needed for a long time, but the confusion occurring in interviewing during the spring of 1948 clearly demonstrated the need for such a code. The Committee on Ethics of Interviewing Procedures, together with 48 representatives of industry and education, met for two days in September. After much discussion, the attached code of ethics was recommended. This code was officially adopted by the General Council of the American Society for Engineering Education at its meeting in Washington, D. C., on November 8, 1948, with the recommendation that it be given widespread publicity among personnel men in colleges and industry.

The Committee which prepared this code recognizes that it is difficult to fit any such code into the operations of all industrial organizations and colleges, but hopes that industries recruiting men at the colleges will recognize the basis on which this procedure was developed and that, insofar as possible, they will conform.

Undoubtedly there are many additional points that might be brought out but in order to have prompt action the Committee, after careful consideration, felt they should immediately present this proposal to industry, the colleges, and the students.

* Prepared by the Committee on Ethics of Interviewing Procedures of the A.S.E.E.

Responsibility of Industry

1. It shall be the responsibility of industry to contact the colleges early enough in the fall so that the schools can plan to take care of those industrial organizations who wish to interview their students. Industrial organizations should not expect to have adequate interviewing schedules set up unless they have notified the schools at least two weeks in advance of actual visits.

2. At the time the student is interviewed at the school he should be informed that within two weeks following the interview he will be advised by the company as to whether or not they are further interested in him and the individual company will let him know within what period he can reasonably expect an offer of employment if he is given serious consideration. However, it is suggested that interviewers be urged not to demand a definite yes or no answer during the first interview. Wherever practices of the organization permit there are advantages in having it send representatives with authority to hire.

3. Industry should provide written material, lectures and other means of preparing the students for the interviews, of a type that will give them a real picture of that industry. This should include information concerning the size, location, type of organization and kinds of people employed; an explanation of any educational program which the industry offers; an adequate description of the type of work the student will do; a summary of the organization's general policies such as labor relations, pensions, etc.; advancement policy including starting salary and whether advancement can be expected on an automatic basis. This

information should be filed with the placement office and not with the students. Also, the student should understand from the industry involved as to whether or not he will be expected to take psychological, aptitude or other tests before being accepted for a job. Such information should include reference to the signing of patent agreements, passing of physical examinations and other incidents to final acceptance.

4. Industry should understand that it cannot place the responsibility in the hands of faculty members to pre-select students unless adequate job descriptions are given so that the faculty can have a sound basis for making such a pre-selection. It should also be understood that the specifications furnished by industry be open to the inspection of the students. It is recommended, however, that wherever possible industry should be willing to discuss possible employment with any student who genuinely desires an interview. Effective pre-selection is the result of mutual agreement between the placement officer (or faculty member) and the student that it is or is not desirable for the student to interview a particular company's representative, based upon adequate understanding of his own aptitudes and interests and reasonable knowledge of the company.

5. It is recommended that wherever possible industry should continue to conduct interviews in lean as well as good years. Your Committee recognizes the many problems involved in this plan, but still feel it should be called to the attention of industry that they, too, as part of the over-all educational plan, have the responsibility of guidance and assistance to students in bad as well as good years.

6. Plant visits arranged by industry should be made with a minimum of interference with classroom schedules, and such visits should be limited exclusively to discussions of the subject at hand. Such visits should be with the full knowledge and general concurrence of the placement officer or faculty member of the school. Overselling and elaborate entertainment of the student should be discontinued.

7. Industry should, in all cases when corresponding with individual professors regarding the interviewing procedure, contacting individual men, or in any way having to do with the employment of students, keep the placement offices fully advised by copies of all correspondence and any other details necessary for their full knowledge of the negotiations.

8. Industrial representatives should recognize the necessity of being punctual and of keeping up to schedules. They should advise the placement office or faculty of the time of arrival in advance of their visit, arrive on time, and keep their appointments. They should be completely familiar with company policies and be prepared to set up adequate specifications of their needs so that the school can do an effective job in presenting the student body to them.

9. Industrial organizations should not expect engineering schools to include specialized courses in their curricula which are primarily useful in particular organizations.

Responsibility of Colleges

1. Placement offices and faculties should, as early as possible in the fall, send to industries lists indicating the approximate number of students who will be available for interviews during the school year. The list should include dates of graduation and should be arranged by courses. We recognize, of course, that frequently it is difficult to know which members of the class will be available for interviews but a five or ten per cent deviation will not be particularly difficult to handle.

2. We strongly recommend that no restrictions be placed on the number of interviews a student can take except that indiscriminate or general shopping around must be discouraged. The schools should provide opportunity for adequate presentation of the story of industry to the interested students. It is

suggested that this need not necessarily coincide with the time of interviews. Industry should be prepared to present their story at evening meetings or at times set up by the schools so that there will be a minimum of interference with regular classroom procedures. Your Committee strongly feels that much of the chaos of the last year or two has been caused by inadequate guidance of students to inform them of what is ahead of them in various industrial organizations. It was suggested that schools might set up a seminar period for all seniors that could be used for such presentations.

3. The schools should provide adequate physical facilities for the conducting of interviews. We recognize the present overcrowded situations but, nevertheless, in all fairness to the student body, each student should have the opportunity of presenting himself to his prospective employer in a way that will not cause him embarrassment and will enable him to present his story without interruption. We do not recommend that the schools do more than provide a small space so that the interview can be conducted quietly and in private.

4. The general program of guidance and orientation should be expanded and improved upon. It was generally felt during the last few years that with the very large number of students, these vitally important items have been sadly neglected.

5. It should be the school's responsibility, especially in those institutions having centralized placement offices, to provide adequate contact with faculty members who have intimate knowledge of the student and his work. Some of the schools have established a "coffee hour" late in the afternoon, a procedure that might well be followed by other institutions. These periods of contact should be conducted during the regular school hours as it is unfair to ask faculty members to stay over in the evening or to give up their personal time.

6. The school records should be available to industry in such a form that where necessary industry can make its own pre-selection.

7. It should be the responsibility of the placement office or dean's office, when an industrial organization is looking for several types of students, to see that there is an adequate distribution of students from various programs available for them to interview.

Responsibility of the Student

1. In anticipation of an interview with an organization it must be the responsibility of the student to prepare himself properly by reading literature, attending meetings at which the story of that industry is being presented, organizing his own thoughts in order to ask and answer questions, and being as fully informed as possible on the type of business conducted by that organization.

2. He should be prompt in meeting interviewers and in handling his correspondence.

3. He should not accept interviews after he has signed up with a company.

4. After accepting an offer he should promptly notify those companies whose offers are to be rejected.

5. He should use care in filling out various necessary forms.

6. He should recognize that failure to answer offers of employment is detrimental to his classmates, and therefore, he should be prepared to make his decision far enough in advance of his graduation so that industry can make its plans.

7. He should keep the placement office or faculty members intimately advised concerning his negotiations.

8. He should recognize that regardless of the number of interviews he takes he should conduct himself in a business-like manner and not expect individual or unusual consideration or entertainment.

9. He must recognize that he must sell himself and that industry can advance him only on the basis of his performance.

Conclusion

It is felt by the Committee and by the representatives of schools and industry

that the placement offices and others involved in the interviewing procedure must be given more consideration by the college administration. In too many cases this procedure is neglected financially and physically. These organizations in the schools should be adequately staffed with clerical or stenographical help; they should have simple but adequate space facilities for interviews; and the placement officers* and others handling the interviews should be given adequate recognition and backing in order to do justice to the important job of starting young college people on their life careers. At most institutions budgets are inadequate. It is recommended that, wherever possible, top administration in the schools should be advised of the importance of the placement and interviewing procedures.

In addition to the above, it was suggested that your Committee on Ethics take the responsibility of preparing a simple one-page interview blank that could be adopted by all colleges and accepted by all industries. This should not in any way be construed as an application, but merely a simple standardized interview form that could be printed in order to save the students and the faculty the laborious task of trying to set up and fill in interview blanks for each individual organization. Your Committee has gathered a large number of interview blanks and submits for your consideration the attached form. It is proposed that this be presented to the Society with a recommendation that this form, on standard $8\frac{1}{2}''$ by $11''$ letter size sheet, be adopted by all colleges.

It was further recommended that your Committee undertake the problem of the development between industry and the colleges of a strong and effective program of vocational guidance—a program to cover all groups of students which should include indoctrination ethics, etc. Your Committee recognizes this may fall in the province of the Committee on Relations with Industry, and it is our intention to present this entire program to that group.

The group meeting in Schenectady strongly felt that the placement offices should be headed by one individual, and where placement offices are used in each of the individual colleges of a university there should be one strong coordinating individual.

Although the material given above is primarily for the American Society for Engineering Education, it was suggested that it be presented through the Secretary's Office to other organizations, such as the American Council on Education, the American Chemical Society and the American Physical Society, so that the same basic procedure can be recognized.

Respectfully submitted,

M. M. Boring

Chairman, Committee on Ethics of Interviewing Procedures of A.S.E.E.

(A Suggested Standardized Interview Blank)

(Photo desirable but should be left to discretion of school and conform to laws of various states where applicable.)

INTERVIEW BLANK

NAME OF COLLEGE OR UNIVERSITY

Name..

Degree Expected..............................Course Taken..............................

Date of Graduation..

College Address..Tel. No.....................

Permanent Address..Tel. No.....................

Date of Birth..Citizen of U. S. A.......................

Hgt.............Wgt.............Single/married.............No. Dependents.............No. Sisters.............

No. Bros.............Parents living.............Father's Occupation is / was.............................

Physical Limitations..

Per Cent College Expenses earned: by Working.............by Scholarship.............by G. I. Bill.............

Quality or Grade Point Average.............Standing in Class.............out of how many.............

Other pertinent info. concerning scholastic achievement..

....

....

Brief Statement concerning any business or other experiences.......................................

....

....

List in order of preference type of work for which you are best fitted:...............................

1. ....

2. ....

3. ....

Do you have preference regarding future location?.............Where?..............................

Honorary Societies..

Extra-Curricular Activities..

....

Professional Societies...

Military Service Record including dates, length of service, location, rank, and educational programs taken..

....

....

....

....

....

No. Months in *active* duty.............Are you a member of R. O. T. C. or active Reserve?.............

Note: Where required I am willing to submit myself to psychological tests and physical examinations as a part of my application for employment..

Signature:..

(name in full)

Expanding Engineering Opportunities*

By DONALD C. HUNT

Industrial Coordinator, University of Detroit

Some doubt may prevail as to what is meant by "expanding engineering opportunities." What we really are interested in is the problem of "finding new engineering opportunities"—expansion generally refers to the increase in size of something which already exists and certainly our large industries will safely do the job of making greater the opportunities within their organizations.

Before proceeding further it might be emphasized that we should not be primarily concerned with ways to take care of the large number of graduates in 1950–51–52, but with the job that will be imposed upon us for a long, long time. You will agree that because of the stimulus that has been given to education by the G.I. Bill, there will be ever increasing numbers of students in school—many more than were anticipated before the war. More young men will go to College in the future because higher education will be demanded in many fields now adequately supplied by graduates of secondary schools. It is this large group of graduates in the years to come for whom we have to provide an opportunity for livelihood in our profession by taking advantage of the present economic conditions and finding and creating new professional engineering opportunities, particularly in those fields which are in a position to utilize technical personnel to a good advantage. Some of these opportunities are camouflaged by a questionable veil of non-professionalism so that many refuse to recognize them.

In this business of finding opportunities the organizations which are potential employers of graduate engineers can be divided into three classifications. First, there is the company with one or two engineers on its staff, or the organization directed by a man with engineering education, none of whom have ever analyzed themselves to the extent of finding out that without their engineer-background they would not be able to do the job they are doing. Yet these same men contend that a business education or perhaps some other diversified field is a better background for their particular work and business, when actually knowledge in these other fields is seldom needed. Men with this outlook really present a selling problem in the "bird-dog" work of a placement director.

Secondly, is the organization with no technical staff, supervised by a high class journeyman or two, and engaged in manufacturing that generally requires systemized production. Such a company usually follows little or no method in its operations—sometimes is highly inefficient through the waste of both man hours and material—the kind of an organization where a young engineer with a little experience and a good amount of active initiative could probably place the business in the category of a successful manufacturing enterprise. These companies have to be indoctrinated by one who is willing to start in the shop, so that he can "get inside of things," and create his own job through his own engineering abilities.

* Paper approved by the Committee on Relations with Industry and presented at the Annual Meeting, A.S.E.E., Austin, Texas, June 15, 1948.

In the third category is the company which hires one or two engineers a year and never knows where to find them. It sounds silly does it not? This year we were contacted by six different companies who had written to several Universities—believe it or not—as a last resort in the recruiting of engineering personnel. They had never contacted engineering colleges before because they did not think the colleges were interested in having them interview seniors, or they felt that larger companies with elaborate recruiting programs hired all the available men. These companies were especially catered to and four of them were able to hire the men whom they needed. Certainly these organizations will continue to recruit their technical employees from the University as long as we continue to serve them.

Let us consider some specific instances concerning companies in the categories mentioned. None of these organizations will fall exactly into any of the categories, but they should give you some ideas on the subject of "finding new engineering opportunities."

Amalgamated Engineering Company of Dearborn, Michigan

The company is principally engaged in steel slitting, including a small amount of fabricating. Steel-slitting, machines in general are rather specialized, and the company has found it very worth while to design and build their own production equipment. This was done primarily by the plant owner, a so-called "self-made engineer," and two skilled mechanics. About eighteen months ago the owner called the University of Detroit to hire a "smart young man interested in shop work," and after a visit to the plant it was decided that one of the better students, especially interested in design, could very easily work into a key position in the organization with a few months work in the shop. After about five months of rather hard production work the young man was asked to help with a design drawing, and he has been doing the design and production layout work ever since. The company is now building a new plant, and it is likely that the young engineer will eventually be plant superintendent.

Klem Chemical Company of Dearborn, Michigan

The principal business of the company is the manufacture and sale of industrial detergents. The president of the company is a graduate chemical engineer and two years ago his chief assistant was the "shipping and receiving plant manager" type of individual whose duty it was to keep the barrels of chemicals coming in, mixing them together, and shipping them out. At that time the president was looking for a man to do a little "test tube work" in an old washing machine into which they threw greasy machine parts and some of their detergents to see if the parts could be cleaned. One of the chemical engineering seniors thought it looked like an opportunity, and he went to work setting up a well-organized laboratory with some modern equipment for detergent investigations. Six months later he had developed some new industrial cleaning compounds in the much improved laboratory, and as a result was given a sizeable interest in the company. The senior has been a member of our Engineering Faculty for the past year, as well as working as a consultant for Klem Chemical Company. He is now back with the company, directing a greater part of their work, including the training of some cooperative engineering students toward a sales engineering career.

Praehler Electric Insulation Company of Chicago, Illinois

Early this spring an inquiry was received from the company regarding an opening for a young graduate electrical engineer. An invitation was extended to the company to interview the seniors who were interested in the position. One of our graduates of the class of 1948 was selected, and I personally feel the opportunity is one of the best offered to this class.

Those are the facts, but here is the story. For about twenty years the company has usually hired one engineer each year, generally someone "self-made" who could do the job because of his extensive experience rather than because of his education. They have usually recruited through newspaper want-ads, but they were never able to get young men to apply. This year they wrote to several Universities and only one ex-

tended them an invitation. The company never knew that engineering colleges allowed small companies to interview their students, and actually did not expect that anyone would extend them an invitation. It was much less expensive for them to send a representative to Detroit than it has been for them to use newspaper advertisements, and then have to read hundreds of applications of unqualified people. We feel sure that another company has been added to those who will recruit annually at the University of Detroit, and several other Universities missed an excellent opportunity.

Hardware Mutual Casualty Company of Stevens Point, Wisconsin

The positions offered by this organization were new to us, and it is reasonable to assume that there are many other similar opportunities where no attempt has been made to place young engineers. The company is in the insurance business and has experienced difficulties in interesting engineering graduates in the field of safety engineering. Most casualty companies have representatives who visit insured plants to investigate plant safety programs, and unfortunately a number of these men are business school graduates with little or no industrial interest or experience. A second interesting phase of their work is the selling of industrial insurance where certainly there is an opportunity for the young man who can talk the language of industry to be of greater service to manufacturers than the average insurance salesman.

State of Michigan

The most important development in my opinion that we have had at the University of Detroit toward new opportunities for engineers is the program now being planned by the Department of Mental Health and State Department of Corrections of the State of Michigan.

Through he efforts of the Michigan State Civil Service Commission, the Department of Mental Health has been interested in the training of mechanical, civil, and architectural engineers to supervise the operation and maintenance of the equipment and facilities of the large state asylums and hospitals. One of the strongest supporters of the program has been the Director of the Department of Building and Construction, a registered Architect and Civil Engineer, who has had tremendous difficulties in dealing with the licensed steam engineers now in charge of these institutions. The State is continually expanding its mental health facilities and much of the work has been directed by the Steam Engineer in charge who has little or no knowledge of the problems in the design and expansion of the necessary operational equipment. It is expected that trained engineers will serve as liaison between the institutions and the Department of Building and Construcion and have complete charge of the maintenance and operation of each of these institutions.

The second program is in connection with the prison industries in three large state institutions. At the present time the position of Director of Prison Industry in one of the institutions is open, and there is no one available for the job because it requires a registered engineer who has had experience in the operation of prison industries. The salary range for the job is $6780 to $8200 per year.

Seventy per cent of the supervision in the industry will retire within five years, and neither they nor the other thirty per cent are qualified for the director's job because they have had no technical training. The industrial operations are rather poorly organized with a very low rate of efficiency because of the lack of qualifications of the supervision and management, and it is expected that young engineers, properly indoctrinated with the problems of prison industries, will do the kind of job that is so badly needed. Obviously, with no possibility of anyone coming up from "within the ranks," the training will have to start at a supervisory level. Such a program of training is rather unique, and it promises to bring forth some interesting situations.

The extensive potential of such programs can be realized if we will consider what the State of Michigan has in mind—105 positions in 25 institutions—then consider this as an average throughout the forty-eight states. One can easily visualize over 5000 new jobs. I am sure they are all new jobs because our state officials have no knowledge of any other similar program. These figures pertain only to state owned institutions; just imagine what might be found if the direction of federal government and private buildings and institutions were investigated.

Briefly this is the story of some of the attempts of the University of Detroit to

expand the engineering opportunities for its students. These opportunities cannot be developed through national organizations of placement directors, as some have advocated, but only through the individual efforts of each college, acting in its own locality. Neither do these opportunities present themselves on the surface. You will have to go into many unenterprising, unimpressive organizations and industries in order to sell these programs. Neither can you do it from an office desk, by telephone and letter, because those people who have never used engineering personnel generally will not bother to answer you.

Most of us are concerning ourselves about the next two or three years of graduating unheard of numbers of well trained engineers, when we should be looking five, or ten, or fifteen years into the future. We are not going back to graduating the few we did before the war, and we will have to continue to find and develop new opportunities in the engineering profession.

In conclusion just a few words concerning the professionalism which has been tossed about regarding a few of the positions some of the men are accepting. Some of you probably disagree with the suggestions, and there are many who feel these positions are not of professional calibre, but many well-qualified, highly professional engineers, particularly in the State government, who are going to hire and train these young men, agree that these positions entail the kind of work that has not been done by engineers, but should have been—these are the jobs that, had they been done by engineers, would have enabled many private and public enterprises to have been more successful.

In the News

Retention of the Taft-Hartley Law definition of professional employees and provisions distinguishing them from non-professionals was urged at a hearing of the Senate Committee on Labor and Public Welfare by a panel representing more than 100,000 engineers.

Pointing out that the present law for the first time defines professional employees and gives them statutory protection instead of making them subject to National Labor Relations Board interpretations, as was the case under the Wagner Act, the panel told the Senators: "There has been a distinct trend away from earlier unsatisfactory conditions and we are well on the way toward complete abolishment of the confusion and distress that existed among professional employees under the earlier law."

The panel was sponsored by Engineers Joint Council and included a representative of the ASEE. E. Lawrence Chandler, Assistant Secretary of the American Society of Civil Engineers, made the presentation as Chairman.

Citing cases decided both under the Wagner Act and the Taft-Hartley Law, the engineers declared: "A fundamental difficulty with the Wagner Act, as it affected professional employees, was that no distinction was made between professional and non-professional employees in spite of the facts that their viewpoints and abilities are inherently different and that their conditions of employment cannot be made subject to a common standard. There is no yardstick by which creative ability can be measured."

The Function and Operation of Technical Institutes*

By MAURICE GRANEY
Head, Technical Institutes, Purdue University

I

Technical institute education is a relatively broad term in that it may be applied to a rather large number of subject matter or occupational areas. However, a predominant trend today is to confine the meaning of the term to those subject matter fields that are closely allied to engineering education.

Any discussion of technical institutes, when the term is so conceived, logically must begin with the 1931 report of the Society for the Promotion of Engineering Education entitled *A Study of Technical Institutes*.

This report held that the four-year engineering schools of the United States were not adequate, either in number or in character, to supply our industries with the desirable quota of technically trained employees. It stated further that the technical institute, uniquely developed and operating within its own distinctive field, could do much to supplement the engineering schools, to offer educational opportunity to thousands of youths, and to ease the burden of in-service training which industry was forced to carry. On the basis of the industrial economy which existed when this study was made, the report indicated that no less than 250 institutes could meet the needs.

In the seventeen years which have elapsed since the publication of this SPEE report, much development has taken place and numerous other publications reporting a less comprehensive coverage of the field have been released. Throughout much of the literature dealing with the technical institute concept, the findings and recommendations are, in general, quite similar. As our industrial economy matures, a resultant change in the structure and objective of our educational organization should follow.

As one glances back to the dynamics of American education in operation, one sees periods of relative activity and periods of relative rest. For those of us interested in technical education, three periods of activity, or transition, appear with equal clarity.

The first of these began to occur as early as 1840. At that time educators realized that the then existent educational structure was inadequate. The vigorous growth of our country was making demands, upon both agriculture and industry in excess of any real hope of fulfillment. The literature of the time points significantly to the fact that men of vision recognized a need for a new emphasis in education. It was not until 1862, however, when the country was in the death grip of war, that the people as a whole became cognizant of this need. As a result of this recognition, the congress passed the Morrill Land-Grant Act of 1862, and therewith made possible the establishment of our agricultural and mechanical colleges. A period of transition had been introduced in the field of technical education.

As early as 1900 educators of vision saw that again our system of technical education was failing to meet adequately the needs of our growing industry. Our sup-

* Presented before the Engineering College Administrative Council at the Annual Meeting, Austin, Texas, June 17, 1948.

ply of skilled mechanics, who had for generations emigrated in large numbers from Europe, was no longer sufficient. As before, the educational literature reflected the apprehension of our leading school men concerning the critical need for a re-emphasis. It was not until the advent of World War I, however, that this need for re-emphasis was comprehended by the people as a whole. Again an act of congress, this time the Smith-Hughes legislation, gave nationwide, formal guidance and stimulation to the revitalizing of our technical education. Again we had broadened the base in a democratic manner. Technical education entered upon a second period of transition.

In both the instances cited, a war had punctuated the development. It seemed as though our people recognized that in order to survive a war, as well as to enjoy a peace, it was necessary for our educational structure to parallel our industrial activity.

We are at this time entering upon a third significant period of transition in the field of technical education. Upon analysis, current developments can be shown to follow, step by step, the development of previous periods. As early as the 1920's our leaders began pointing the way. The studies made show clearly the attitudes and conclusions of our men of foresight. This time it was not the engineering college nor the vocational school which was envisioned. It was the technical institute. This time, with the emergence of World War II, even the most sluggish thinker could recognize the acute, the almost fatal deficiency in the supply of technically-trained personnel. World War II was fought in our factories, on the production lines, as well as at the battle front. To survive war, as well as to enjoy peace, we need trained men in the myriads of technical assignments in industry.

You all recall the feverish activity of our colleges during the recent war. The United States Office of Education sent out the call. Our colleges and universities responded. There were the E.D.T., E.S.M.D.T., and E.S.M.W.T., initials familiar to most of you. In these three war programs Purdue University trained over sixty-thousand persons for employment in Indiana industries. Other schools reacted similarly to a greater or lesser extent, so that the total trainees in these programs exceeded on and one-half million.

But such training was for an emergency. It was temporary. However little or however great the benefit to industry and to the war effort of this activity, it held no promise for a continuing, well-balanced reorientation of our educational activity.

It was at this point that attention was squarely directed to the consideration of a long range, permanent plan, a plan which would bring our formal educational activity more nearly into line with the real environment in which it operated.

II

The Purdue University Division of Technical Institutes was established in 1942. It is a part of the permanent plan of Purdue. It offers a program of intensive, specialized study designed to meet today's industrial needs for technically trained employees. Six different curricula are offered. Each curriculum has as its objective the training of persons for a small, closely related cluster of jobs in industry, and includes studies intended to develop social understanding as well as technical competency. The positions for which the training is given are technical in character, and lie between the professional engineering activities on the one hand and the skilled crafts on the other. High-school graduation is a prerequisite for admission, and credit granted for the courses studied applies toward a technical institute diploma. Each plan of study is two years in length, although there is opportunity for additional specialized study. None of the work is given on the campus in Lafayette, but is offered in six extension centers located in various industrial cities. Instruction, for the most part, is given in formal classes, a high percentage of which are laboratory. Full-

time day students and part-time evening students are enrolled.

Classes were first offered in 1943 at the extension center located in Hammond. At that time only part-time evening courses were scheduled and the first registration netted only 39 students. The Technical Institute program was expanded to other centers from time to time. In 1945 full-time day students were admitted. In September of 1947 six centers, Ft. Wayne, Gary, Hammond, Indianapolis, Michigan City and Muncie, were in full operation with a total enrollment in excess of 1,000 students, about one-half of which attended full time.

At present the six curircula offered are: Building Construction Technology, Chemical and Metallurgical Technology, Drafting and Mechanical Technology, Electrical Technology, Production Planning Technology, Supervision and Production Technology. Each is organized in a similar way. There is a core of fundamental, technical material covering mathematics, chemistry, physics, drawing, and English. This composes about one-half of the total program and is the same for each curriculum. Likewise a uniform list of nontechnical studies is a required part of each curriculum. This list of courses embraces economics, government, psychology, and speech, and totals about one-seventh of the whole requirement. The remainder of each program, roughly one-third of the total, is composed of specialized courses in the particular major field. The distribution of time between technical, specialized and general subjects is constantly being scrutinized to make certain that those who complete technical institute programs have an appreciation of good citizenship and human values as well as technology.

Each of the courses is specifically designed to give the students a maximum amount of instruction which is usable in a limited time. Emphasis is placed upon the practical, the applied, rather than upon theoretical study. Some courses are unique in content and purpose. Others have their counterpart in courses in an engineering curriculum, but the treatment and the emphasis are different.

Much of the unique quality of the Technical Institute is derived from its teaching staff. Part-time as well as full-time teachers are used. Part-time teachers are used more frequently in evening classes than in day classes. In general they teach courses lying within the field of their daily work experience. For this reason they bring much that is practical, much that is applied into their teaching. At present, the full-time staff numbers 45. These teachers are responsible for doing the major portion of the day time instruction. Four qualifications of this staff are of major importance: (1) previous industrial experience, (2) personal interest in and enthusiasm for the Technical Institute, (3) sound academic training, (4) previous teaching experience.

The student body of the Technical Institute has some interesting characteristics. To date over ninety-seven percent of the students enrolled have been men. While there appear to be excellent industrial opportunities for women who receive this training, few have availed themselves of it. An increase in this number may take place in the future. Another interesting statistic concerns the previous academic training of the students. While the program does not presume to give as comprehensive a coverage as does the four year college course, there were, at the last analysis, nearly seventeen per cent of the students who had had previous college instruction. A few of these students have held bachelor degrees. A majority of all the students have had some earlier work experience.

Student reactions are diversified and quite frequently emotionally-toned. Some students support the program with an almost religious fervor. Others take the more prosaic attitude that this is the only program they have found which prepares them for the kind of employment they want. Still others express a certain humiliation because the Technical Institute does not grant the bachelor degree. A number of students express regret that

credit earned for courses in the Technical Institute is not transferable to a large number of similar schools in the country. It is not so much that such students wish to leave, but that they want the security which comes from being a part of a large and recognized activity. It seems certain that the accrediting program now being sponsored by the Engineers Council for Professional Development will do much to alleviate this feeling of uncertainty.

Thirty-three students were graduated as Associate Technical Aides before the present year. Roughly one hundred fifty more will be graduated June 26, 1948. Of those already on the job the majority are working in technical capacities, most frequently in industrial engineering departments. A recent follow-up showed that their superiors held attractive goals in view for about ninety per cent of the graduates. Of the one hundred fifty to be graduated this term, all have either accepted employment or can do so from the contacts already made. Indiana industries would take ten times the number of graduates available in certain fields.

Industry as a whole has been most cooperative and helpful. Thanks in no small measure to the enviable record established by the Purdue graduates in Engineering, industries have felt that the Technical Institute would do an equivalent job in its own field. The activity has been supported through its entire development by the industries of the state. Many students have worked part time during their school enrollment, either on a cooperative basis or as free lance employees. To date a limited number of genuine cooperative programs are in effect. The most recent of these was developed in cooperation with the Inland Steel Company of East Chicago, Indiana. The plan was initiated last term. Under this plan forty-four full-time employees started attending specific classes one day each week. The schooling for each student will last a period of two years. Our discussions with the company lead us to believe that the number of students will be increased to two hundred when the fall term starts in September. This Purdue-Inland Steel cooperative program is cited to show that the Technical Institute, in order to fill its real function in society, should and can work closely with its contemporary industrial institutions.

What does the future hold for the Technical Institute at Purdue? The program is too new and the experience is too brief to enable one to predict with much certainty. There is, however, a reasonable basis for a few rather general statements. One, if the performance of the first graduates is of high quality, the opportunity for those who follow will be assured. Two, if the program maintains an attitude of genuine flexibility which will enable it to integrate instruction with the changing needs of the times, it need not fear the stagnation and rigidity which have characterized all too many educational activities of the past. Three, and last, the Purdue program quite likely will stand or fall as does the whole trend of technical institute development in the country.

III

What, then, is the future for this inclusive group of schools called technical institutes?

Programs are presently in operation at other state schools not too different from Purdue. This reference is to such schools as the Pennsylvania State College, the Oklahoma Agricultural and Mechanical College, and the Georgia School of Technology. As at Purdue the technical institute is, in each case, closely allied to a state engineering school. Recognizing differing needs due to geographical location, one must concede that all of these programs should eventually develop in a similar manner. It seems a fair prediction that, in the future, other state engineering schools will, in like manner, sponsor a technical institute.

There is also the significant development being carried on in New York State. This is representative of a type of public program which has evolved in varying form in California, Connecticut, New

Jersey and Massachusetts. A number of these schools are in a process of organization or reorganization. It is difficult to evaluate critically their relative place in the entire pattern of technical institute development. Two things, nevertheless, seem to be characteristic. One, these schools offer a more diversified subject matter than do those which are divisions of state universities. Curricula in agricultural, biological, and commercial fields are almost as numerous as curicula in fields closely related to professional engineering. There is no question that such diversity is a desirable and genuinely needed development. Two, these schools, being sponsored by states or municipalities, can be expected to have real continuity and permanence.

In addition to these two groups of publicly supported schools there are a number of privately endowed technical institutes. Some of these schools, such as the Franklin Technical Institute, the Ohio Mechanics Institute, the Rochester Institute of Technology, and the Wentworth Institute, have enjoyed a long and successful history. In general such schools tend to stress shop activities to a marked degree. At the present time it seems reasonable to believe that the future of endowed schools such as these is secure.

There is also a considerable number of proprietary technical institutes. Such schools are frequently organized to offer instruction in only one subject matter area. When such schools are carefully organized and managed, and when they sincerely meet a genuine need, they fill a unique and important place in our pattern of education. Examples of such financially self-sustaining schools are the Bliss Electrical School and the Capitol Radio Engineering Institute.

Somewhat different, yet functionally the same as the technical institute, are the junior colleges which offer terminal programs. In the past, the curriculum of the junior college has been to a marked extent dominated by state universities and other important institutions of higher learning. This has resulted in a program largely a replica of the first two years of the regular four-year work. In our present transition, however, terminal curricula, both vocational and general, have been introduced. Starrak and Hughes in the recent book "The New Junior College" state that "Terminal curricula are designed for students who wish in one or two years to . . . acquire vocational training which will lead to employment in semiprofessional fields." These authors hold further that a few junior colleges have whole heartedly attacked the problem of providing such instruction without sacrificing their regular college offerings. The success of such ventures, they claim, casts doubt upon the argument that non-degree and regular instruction cannot be carried on in the same institution. There is reason to believe that more work of this character will be developed in junior colleges as time passes.

Telling the Story of Engineering Research

By JOHN I. MATTILL

Secretary, Engineering College Research Council; Assistant Director of News Service, Massachusetts Institute of Technology

"Unique" is one adjective universally applied to the winter session of the Engineering College Research Council in Washington, D. C., on November 8, 1948. Seven speakers, all authorities in the newspaper, magazine, and radio field, told the assembled college and research administrators about the problems and methods of those media upon which all engineering depends for its contacts within and beyond the profession. The specialists spoke to the general title, "Telling the Story of Engineering Research."

Scientists and journalists have come together for similar meetings on rare previous occasions—but never, so far as the E.C.R.C. knows, in a program specifically developed for engineering research. One of the Washington speakers said the subject "hits at the roots of some of the towering problems which confront our society today." Another called it "the most important activity every college and every individual scientist should concern himself with."

A complete Proceedings of the E.C.R.C.'s Washington meeting is now in preparation; it will be supplied to all E.C.R.C.-member institutions and will be available to other A.S.E.E. members following its publication, notice of which will appear in the Journal of Engineering Education. Meanwhile, there follow selected excerpts from the seven speakers' remarks.

* * * *

If democracy is to continue without another long interval of general authoritarian darkness, the great mass of our people must learn and appreciate what scientific methods and principles are, what they can (and cannot) do to make our lives more comfortable, more secure, more humane –and what they cannot do in the face of lagging public opinion, dogmatic legislation, forced recruitment or diversion of effort when war is a world epidemic.

If higher education is not to stand still or retrench, its benefits to society at large must be increasingly apparent to the public, for the public and government will gradually have to shoulder the financial burdens formerly borne by the enlightened and wealthy. So the question can be put on a very practical level for you.

Let me assure you, the work of a newspaper science editor is not easy. Simple words, appropriate alliterations, similes, examples the public can understand, are often hard to find on the spur of the moment to explain scientific terminology. It is especially hard when no advance copy of a scientific paper has been made available for us to study. Many times we must depend upon hurried notes made in a darkened lecture room and try to rediscover what was said, or what we thought was said. Meanwhile, in the room beyond, the teletype jangles as edition time nears.

Thus it is that a scientist stands a much better chance of being quoted correctly if reporters have in writing the substance of what a technical paper is about, in advance. But the scientist who has taken care to provide a non-technical abstract for the press should not be disheartened

if it does not appear just as he wrote it. Most large dailies have an iron-clad rule that every release must be rewritten before it appears in the paper.

I frequently hear the thought expressed, "My work is too technical for the public to understand," or "I don't want to talk about it yet; my results are not conclusive enough." I have proven to my own satisfaction many times over that no scientific study is too technical to explain to laymen unless it is of consequence *only* because the findings add some details to the general background of knowledge.

To separate news of real scientific advancement from things of small importance to the general public, I generally asks two questions of each potential science story: (1) Does it show how research and engineering are helping to overcome human lack and physical limitations? and (2) Is this a subject of interest to all readers who wish to be informed? [1]

There are two sides to the gulf that separates the lay reporter from the highly-trained, highly-specialized scientist. By and large it is a tremendous gulf, and no half-measures will bridge it. If the press shows a willingness—and I am proud to believe that it not only does, but increasingly will do so in the future —to bridge the gap from its side, then science can do no less.

A regrettable sum of scientific writing for the lay press is nothing but nonsense fortified with technicalities—and it is largely the fault of science that this is so. The avalanche of utterly unintelligible English which is dumped upon the long-suffering press by science in a single year is ghastly.

If you must speak of torque or torsion, borrow a cigar from one of your colleagues, twist its ends in opposite directions, and show the twisted fragments to the puzzled reporter sitting at your feet. His face will light with the beneficent light of the dawn, and he will love you forever and forever. For you will have slain a dragon in his way.[2]

Science Service, the institution for the popularization of science, was founded in 1921 by men who realized the immediate need for accurate, "palatable" information about science. For the first years of its life, the institution was engaged in a great crusade.[3] Today, it is proud to be in a highly competitive situation, racing with and supporting the efforts of all types of popular media to bring science to the public.

Science Service has always sought to tell the story of scientific and technological progress as news. Its newspaper syndicate services now include a daily leased wire report of 800 words reaching newspapers across the nation, a daily mail report to newspapers, a weekly science page, and other syndicated services.

News of science, prepared for the newspaper syndicate, is also published by Science Service in the weekly *Science News Letter; Chemistry* magazine is a monthly Science Service publication. Oldest science program on radio is Adventures in Science, conducted by Watson Davis, Director of Science Service, over the Columbia network.[4]

There is also a growing demand for news of engineering in magazines of general circulation. The problem here is entirely different from that involved in disseminating information about engineering research through the medium of the

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[1] Preceding paragraphs from "Applied Science in the Daily Press," Herbert B. Nichols, Science Editor of the *Christian Science Monitor* and Past President of the National Association of Science Writers.

[2] Preceding paragraphs from "The 'Working Press'," John M. McCullough, editorial staff of the Philadelphia *Inquirer*.

[3] The story of Science Service is told by Watson Davis, Director, in "The Rise of Science Understanding," *Science*, September 3, 1948, Vol. 108, No. 2801, pp. 239–46. Reprints are available from Science Service, 1719 N Street N.W., Washington 6, D. C.

[4] Preceding paragraphs from "Science Service," Ron Ross, News Editor of Science Service, Inc.

newspapers; the larger group of magazines today rely not only on interesting titles but on interesting art work, either photographs or drawings, to attract their readers. And these must be of "eye-catching" quality.

The engineer is inevitably going to be startled by the idea of translating his research into what a magazine art director would call a "stopper" or an "eye-catcher." But dramatic treatment can, by careful cooperation between artists and scientists, be highly accurate.

When a magazine undertakes an article which must be illustrated, it usually employs highly competent photographers, as interested as the engineer in accurate portrayal. If the cooperating engineer is doubtful about the effectiveness of a certain picture which may be suggested by a photographer, it is advisable (nevertheless) to take the picture he has in mind. Often this is done with the stipulation that it will not be published unless the cooperating engineer is satisfied with the result. Most editors will allow the engineer to see an entire article before it is published, but in asking for such critical reading editors are *not* seeking censorship of style.

Magazines have a special problem: they lack the "spot news" appeal of the daily press and the technical appeal of the engineering magazines. Their task of making technical developments compete with more popular subjects can only be done with the fullest cooperation of the technical experts. The engineer must rely on the editor's point of view as much as the editor must rely on the engineer's technical wisdom.[5]

With radio, the important thing to remember is that the listener makes the ultimate choice; he picks from the complex fare that is served up to him those things that he most wants to hear. This problem has an additional aspect: the reader has paid for his newspaper or magazine; what he gets on the radio is free and bears no economic compulsion.

The common ground between the science specialist and the radio specialist is the frame of reference of the listener. Our problem is this: How can we apply the frame of reference of the average citizen to the material and method of science? We can do so by extracting from the research picture those aspects which meet the average citizen's problems and desires: the ideas and things that may challenge, stimulate, inform, entertain, or assist him. This is the key. The research laboratory is privileged to have science for science's sake. On the radio, we can only have science for the listener's sake.[6]

There is no subject more newsworthy than scientific research; it appeals to the public, but particularly it appeals to the readers of technical publications, the "business press."

While a prepared statement of some sort is very necessary for the guidance of the business press writer who will handle a story, an opportunity should be given, if at all possible, for the writer to ask his own questions about the development. Each business paper wants a story that is different from one appearing in a competing publication; if a writer has a handout only, he has little chance to develop an article that will be different from that appearing in other publications.

Research laboratories are located in many places where the press is not numerously represented, but I know of no business paper that would not make an arrangement with someone, even in the smallest community, to supply reports from a research laboratory if there was any prospect of a reasonable amount of news.[7]

[5] Preceding paragraphs from "Photographs and Diagrams: How the Magazine Can Help," Edward D. Fales, Associate Editor of *Science Illustrated.*

[6] Preceding paragraphs from "Science on the Radio," Irving J. Gitlin, Science Director, Columbia Broadcasting System, Inc.

[7] Preceding paragraphs from "The Business Press," Paul Wooton, President of the National Conference of Business Paper Editors.

The technical engineering press is an integral part of the business press; like any other business paper, a technical journal addresses a unified group of readers, all of whom work in the same field. As with any other business paper, the subscribers read it solely to get practical aid in carrying on their specialized vocations. It takes a great deal more work and knowledge to write a story suitable for a few strictly technical magazines in any engineering field, and the resulting readership, at best, will be measured in thousands rather than in millions. But do not measure the effectiveness of publicity by counting only reader noses, for the readers of these engineering magazines are a select group—about the only men anywhere who can make any real use of your research information.

Each specialized engineering magazine will require its own special slant on any research story. If you are running a major research on the properties of stainless steel, this should be reported in five different ways for five technical magazines concerned, respectively, with the steel industry, arts and decoration, architecture, chemical technology, and machine design.

What the technical magazines really need is a tip service; many of us in engineering journalism are now regularly overlooking important research stories in our fields because they are not specifically brought to our attention or are buried in bulky tabulations in projects outside of our fields. When we do hear of projects that concern our readers we are perfectly willing to do our own writing, studying and digesting of long technical reports.[8]

If ever two broad fields of endeavor dwelt under the same roof tree, science and journalism do. I hope that this program may have indicated how we may sit down at the same mess, share our bread and salt, our water and wine . . . as, indeed, we *must* do.[9]

[8] Preceding paragraphs from "Research in the Engineering Press," Philip W. Swain, Editor of *Power*.

[9] Preceding paragraph from "The 'Working Press' ", McCullough.

Divisions

The Engineering Drawing Division of the ASEE held its Mid-Winter Meeting at the **Ohio State University** on January 29, 1949. F. G. Higbee gave an illustrated lecture on "The History of Drawing." Other speakers included: A. H. White, "Contribution of Engineers to the Industrial Age"; W. L. Everitt, "Engineering Research"; P. N. Lehoczky, "Engineering Education"; B. R. Van Leer, "Professional Responsibilities of an Engineer"; L. E. Schick, "Military Graphics"; H. W. Stertzbach, "Development of Railroad Rolling Stock Specialties"; J. A. Flint, "Development of Conveying and Mining Machinery"; G. R. Logue, "Trends in the Design of Highway Bridges"; and S. Renshaw, "The Visual Third Dimension."

Summary of E. C. R. C. Meetings Held During 1948

The two important meetings of the Engineering College Research Council in 1948 include the annual meeting at Austin, Texas, June 16 and the Winter meeting in Washington, D. C., November 8.

At the Annual meeting, institutional representatives planned the distribution program for the E.C.R.C.'s brochure, "The Pay-Off in Research," which was very favorably received. They decided on a joint distribution by individual member institutions to alumni and friends and by the central organization to principal industrial research laboratories. The representatives voted not to publish at this time a second and similar volume giving case histories from other member institutions.

Plans for a new issue of "Review of Current Research and Directory of Member Institutions" were also reviewed at the Annual meeting. Members decided the E.C.R.C. should cooperate with the Association of Land-Grant Colleges and Universities in the submission of questionnaires for information to eliminate duplication of work.

The Chairman, F. M. Dawson, announced that the next Annual meeting would be held at Rensselaer Polytechnic Institute, Troy, New York, during June 1949.

At the Winter meeting in Washington, D. C., the E.C.R.C. Executive committee continued the appointment of Mr. John I. Mattill as Secretary and appointed Mr. John P. Weber as Assistant Secretary in the office of the chairman.

The Secretary reported on administrative activities including the second printing of "The Pay-Off in Research" and editorial work on the "Proceedings of the 1948 Annual Meeting."

The Executive committee also authorized the chairman to proceed with publication of the 1949 "Review of Current Research," and made tentative plans to preserve and circularize the papers presented at the Winter meeting.

Besides discussing initial program plans for the 1949 Annual meeting at Rensselaer Polytechnic Institute, the committee considered bringing the Research Council into participation in the conference on the Administration of Research at the Pennsylvania State College, provided other groups concerned with the conference favored such participation.

The Executive committee also voted to continue the Committee with Industrial Research Groups under the chairmanship of Dean W. A. Lewis for the balance of the year with recommendations for liaison with the A.S.E.E. Committee on Relations with Industry.

1948 E. C. R. C. Proceedings Available

Publication of the Proceedings of its 1948 Annual Meeting at Austin, Texas, has been announced by the Engineering College Research Council. The contents include ''Cancer Research Needs Engineers,'' by Dr. C. P. Rhoads, Director of Memorial Hospital, New York City; ''Problems and Importance of High Temperature Metallurgy,'' by Dr. C. T. Evans, Jr., Chief Metallurgist for the Elliott Company, Jeanette, Pennsylvania; a national survey of research projects in mechanical engineering; a symposium on the administration of sponsored research in four educational institutions; and the Annual Reports of the Officers of the Engineering College Research Council.

Copies of the 1948 Proceedings are available from the Office of the Chairman of the Engineering College Research Council, Dean F. M. Dawson, at the State University of Iowa, Iowa City, Iowa, at $1 each.

Geology for Civil Engineers

By JOSEPH M. TREFETHEN
Professor of Geology, University of Maine

The relationship between civil engineering and geology is as old as the hills, man-made hills that is. Egyptians built enduring and, to borrow a Hollywood adjective, colossal structures of stone on secure foundations. Today there are many to whom the structures of ancient and medieval engineers represent the peak of strutural achievement. There is, however, a vast gulf between a pyramid and an empire state buiding. At every hand in the modern world are wonders more wondrous than the classical seven. In modern engineering safety factors have been reduced; innovation of all kinds, of materials, of methods, of function, have been introduced. And the scales of size, weight, and use have been multiplied many fold according with the advances of technology. No structure, however, is better that its foundation or than the material it is made of. Indeed, the majority of modern failures are those due in some measure to underlying geological causes. With recognition of these causes of failure, and because of the responsibility inherent in heavy construction, which in the building of a single large dam may entail hundreds of lives and millions of dollars worth of property, the use of geology as a tool of engineering has become an integral part of modern engineering practice.

In a competitive economy, good engineering is not creating the best possible structure; good engineering is making the most economical structure that will satisfactorily fulfill its purpose. In the interests of economy, therefore, as well as of safety, more and more use is made of geological skill: in the investigation of sites; in the search for construction materials; during construction; and in some types of engineering, continuing through operation and maintenance. Illustrations of economy in construction made by virtue of geological examinations are commonplace today. A few examples will illustrate the point. The decision to leave unlined a nineteen mile stretch of the Friant-Kern Canal, based on knowledge of the underlying rock, saved an estimated $2,000,000.[1] At Kortes Dam, Wyoming, it was considered that no local sand and gravel suitable for concrete was to be found. A geological examination revealed a suitable source close by.[2] On a county road job in Maine several years ago a crew of forty men, four trucks, and a shovel operator were kept idle for half a day while the engineer in charge tore wildly around with a test pit crew trying to locate a new gravel bank—the shovel had been set into a bedrock ridge; the new spot selected for operation proved to be the same. In one state, a soils specialist conducted a material survey for a twenty mile stretch of concrete highway. His boast was that every slope within ten miles of the job was test-pitted. He overlooked some "flats" of glacial outwash. Evidently even on small jobs economies are possible if geology can be applied at the right time and place.

Application of Geology in Civil Engineering

The civil engineer meets a variety of problems in which geological training is

[1] Rhodes, R., and Irwin, W. H., "What the Engineering Geologist Does," *Engineering News Record*, Vol. 139, 1947, p. 528.

[2] *Ibid.*

of service. Inevitably he will learn more geology in the field and in practice than can be taught in classroom or college laboratory. But he will learn it more quickly and apply it more effectively if his engineering course has included the basic principles of geology. Several specific aims of a properly organized course in geology for engineers may be particularized.

First: it gives the engineering student a systematic knowledge of *materials,* their occurrence and properties. Although every contractor or engineer who deals with rock or soil gains this knowledge by experience, the "practical" way, the path is smoother and straighter for the young engineer who has studied them under professional guidance. The sources, types, and characteristics of geological materials, therefore, are geological fundamentals for engineers.

Second: *foundation problems* are directly geological. Buildings, bridges, dams, highways, and other structures are built on or in some natural material.

Third: *excavation,* whether open or underground, can be more intelligently planned, directed, and more safely carried out if cognizance is taken of the type and structure of the material to be removed.

Fourth: a knowledge of *surface waters,* their methods of erosion, transportation, and deposition, is essential for river control, coastal and harbor works, soil conservation, and other projects.

Fifth: a knowledge of *groundwater* occurrence and the elements of groundwater hydrology is helpful in many branches of engineering practice: in sanitary engineering, water supply, land drainage, irrigation, excavation, control of landslide and frost heave, and many other works.

Sixth: the ability to *read and interpret geologic reports, geologic and topographic maps, and photographs* is of assistance in planning most projects. The nature and distribution of soil and bed rock types and structures can often be deduced successfully from the topographic map or airplane photograph. A good geologic map can be translated into a three dimensional picture or model of the area. Ability to interpret geologic maps is essential, also, to the comprehension of geologic reports.

Seventh: an *ability to recognize the nature of geologic problems* as they are encountered and to discriminate those which require a specialist's study is a valuable asset; and a familiarity with the concepts of geology and with the technical language that often obscures them is likewise often of value.

Not all of these advantages will be realized from any program of formal study. Many experienced contractors and engineers seem almost intuitively to recognize and solve the simpler geologic problems. Others of equal experience with added study never seem to assimilate or apply simple geological principles. For the majority, however, who fall into intermediate classes, geology will be a useful tool if the training is oriented somewhat as outlined.

Geology—A Young Science

The engineering student, fresh from courses in physics, mechanics and surveying, in which data are quantitative and results are precise, is often surprised and repelled by the necessarily meager quantitative data and qualitative aspect of geology. This is an altogether healthy and natural attitude. Although some phases of geology have been rigorously treated for years, in many phases the science is only now at the beginning of the quantitative stage. Nature has imparted limits that can be appreciated best in the field. Geological structures were not designed by handbook and slide-rule; heterogeneity of material and slope, of composition, structure, and water content, of strength, hardness, and solubility, and of many other elements prevails—heterogeneity that precludes mathematical analysis or rigorously quantitative treatment of some phases.

Many engineering projects require the services of one or several professional

geologists who are specialists in the particular part of geology in question. These men are consultants who assume no responsibility for the final success or failure of a project; that responsibility rests on the engineer in charge. The consultant's job is to present geological data bearing on a particular problem or series of problems clearly, fully, specifically, and quantitatively within the limits set by the employer and those set by nature. It is necessary that someone in the engineering staff read, understand, and translate the geological findings into design and construction practice.

The engineer wants numbers representing answers to certain definite questions. A false sense of security and mastery of matter is sometimes the result of assumptions of numerical data, or from extension of numerical data to unwarranted applications. An assumption may be concealed by mathematical transformations or obscured by repetition. However, the engineer must have, find, or assume satisfactory quantitative answers for many problems. And in the process of arriving at them has made valuable contributions to geological knowledge. The science of geology, nevertheless, even where qualitative, may serve the engineer well, and while receiving much from engineering practice, gives much to the practicing engineer.

The aim of the required courses in geology in the engineering schools is not to make geologists out of engineers, but rather to present certain fundamentals of geology, slanted towards practical application, to engineering students many of whom will be confronted with various geological problems early in their professional apprenticeship. Such a course of study should enable the engineer himself to make use of geology as a tool, and also to use the geological investigations of others in the course of his professional practice.

. . . *theme for the year*

PARTNERSHIP WITH INDUSTRY

Summer School for Mechanical Engineering Teachers
June 25—July 1, 1949

The Mechanical Engineering Division of ASEE, with the cooperation of ASME, is planning to sponsor a summer school for Mechanical Engineering teachers at Rensselaer during the period, June 25 to July 1, 1949, inclusive. The chief emphasis will be on the teaching aspect of Mechanical Engineering subjects.

The program has been made rather broad and includes material which will be helpful to the instructor in planning for his professional development. The following are some proposed subjects to be covered:

1. Teaching methods.
2. Professional development of the instructor.
3. Presentation of subject matter for general and specialized Mechanical Engineering courses.
4. Integration of the curriculum.
5. Professional development of the student.
6. Preparation of student for his first job.

This is an ambitious program but the Committee feels that while the subjects can by no means be exhausted, a critical review would be of help to both new and experienced teachers.

Several colleges have graciously extended an invitation to the Mechanical Engineering Division of ASEE to hold its summer school on their campus. Since the general sessions of ASEE will be held at Rensselaer from June 20 to June 24, 1949, the Executive Committee felt maps, and i-vitation to hold the summer planning most t campus should be accepted. distribution of that this arrangement would structures can -nient for the largest num- fully from the t plane photograp]

Preliminary estimates made by Rensselaer indicate that the cost of room and meals will probably be less than $40.00 per person for the week.

The Mechanical Engineering Division activities of ASEE in the annual program are on the last two days of the meeting and immediately preceding the summer school dates. For those who will attend both the summer school and the annual meeting of ASEE, an early application may make it possible to be housed in the unit which will be used by the summer school following the annual meeting.

One of the features planned for this summer school is an Old-Timer's Day. This is scheduled for Saturday, June 25. It is hoped that we will be able to interest the older teachers (including those who have retired) who have done outstanding service in Mechanical Engineering teaching in participating in this program. One of the highlights planned is a Recognition Dinner on Friday evening at which time the Mechanical Engineering Division of ASEE will express their appreciation of the contribution these men have made to the engineering teaching profession and to the engineering profession in general. The following day it is hoped that a program can be developed whereby these men will have an opportunity to discuss subjects of interest to young instructors. The opportunity to meet and hear these men will not only serve as an inspiration but the advice and counsel which they can give should be of great value.

For further information write Professor E. N. Kemler, College of Engineering, New York University, New York 53.

Success Factors for Young Engineers

By E. C. KOERPER
Research Coordinator, A. O. Smith Corporation

An adequate introduction of the young engineer to his new job is of vital importance to him, his employer and to his profession. This, with continued technical and professional development, prepares him more rapidly to assume and discharge his professional responsibilities. This integrated approach is to be encouraged for the benefit of all concerned.

The development of professional concepts in the engineer is a dual responsibility: First, the associated senior engineer must point out the vital need for it and guide toward it; and second, the young engineer must ever remain willing and anxious to widen his fields and deepen his knowledge along various lines, not just a small part of one. From long observation it appears that there are certain broad areas through which an engineer can broaden his lot. He should:

1. Understand the practical applications of his academic work. This is based on judgment coming from carefully observed and correlated experience.

2. Develop an organizational sense. This is "knowing your way around" the organization, knowing its policy and the working relationship between functions, departments, etc.

3. Understand the economic significance of your decisions. This includes a broad practical view of the product or service as related to the customer's requirements.

4. Develop a sense of professional balance and relations. This includes a regard for the public good and the responsibility for professionally contributing to it, as well as a sense of loyalty between professional men.

5. Develop insight in yourself and associates for the best possible balance of personal and social adjustment. This is important.

Doctors and lawyers take six to nine years of formal education, while an engineer takes only four to six years. There are many opportunities and constant need for strengthening one's technical ability. The man who continues to grow mentally can be a leader; the man who does not continually develop soon falls far behind.

Personal success is never accomplished without a degree of personal leadership. This is based primarily on your acceptance as a human being because you are liked and respected and well adjusted. It is entirely aside from your technical ability.

Check personal and social adjustment of yourself on the following:

1. Sense of belonging. Get sufficiently close to your organization and projects to be part of it and be recognized as such. Recognize the relation and need for it in others.

2. Sense of importance, or of being needed. Attempt to so prepare yourself that you can take increasingly important responsibilities in the work you are now doing or planning. Provide incentives for others to develop by recognizing their ability and using it.

3. Sense of accomplishment. Follow through on projects and ideas and see them actually accomplished. Help others to follow them. Too many projects are dissipated without completion.

4. Recognition. Provide definite but modest steps to be recognized for a portion of the work you have done. Other

people also desire recognition. See that they get their share in order that they recognize in you potentialities of personal leadership.

5. Sense of security. No one is ever secure this side of the grave. Relative security comes with experience, integration into the organization and the amount of your integrated contributions.

This outline covers only a few of the points that contribute to your success as an engineer. The applications of these points and others you may have are wholly yours to initiate and follow thru.

E. C. R. C. Booklet Available

"Telling the Story of Engineering Research," a 48-page illustrated booklet containing the full texts of seven papers by nationally-known journalists given before the Engineering College Research Council in November, 1948, is now available from the Office of the Chairman of the Research Council, Dean F. M. Dawson, at the State University of Iowa, Iowa City.

The contents include comments on science writing by Herbert B. Nichols, *The Christian Science Monitor;* John M. McCullough, Philadelphia *Inquirer;* Ron Ross, Science Service; Irving J. Gitlin, Columbia Broadcasting System; Edward D. Fales, *Science Illustrated;* Paul Wooton, National Conference of Business Paper Editors; and Philip W. Swain, *Power*.

Members of the Society and all officials of E.C.R.C.-member institutions may obtain copies for 35 cents, somewhat below actual cost of production; for others the price is 50 cents each.

Basic Educational Training for Sanitary Engineers*

Report of Committee on Sanitary Engineering, Civil Engineering Division

This committee was reactivated after the last annual meeting of the society at Minneapolis. This report follows a lead which the old committee had started, and is an attempt to present a preliminary statement of basic educational training for sanitary engineers.

Sanitary Engineering

Exactly what is meant by "sanitary engineering" needs clarification, since there is considerable confusion as to what is included. To many persons it seems to be restricted to problems connected with water supply, sewage disposal, and stream pollution. This is far too restrictive, although it may include most of the work normally done by those sanitary engineers whose basic training has been in the civil engineering field. It would exclude a high percentage of those actually engaged in present day sanitary engineering, and probably an even higher percentage of those who will engage in it in the future, since it does not include many who are engaged in public health work, in the operation of water and sewage treatment plants, and in industrial sanitation.

Dr. Emerson some years ago stated that public health work was either hygiene or sanitation, and that hygiene had to do with all that an individual could do himself or have done to him that would make him physically better able to overcome factors in the environment or in his own physical constitution that might cause physical or mental ill health. Sanitation was defined as including all controls or modifications of the environment undertaken in order to protect men from conditions that might adversely affect health, if these controls were not provided. Then by definition sanitary engineering would be all engineering undertaken for the purpose of improving the healthfulness of the environment.

A detailed definition of a sanitary engineer was passed by the National Research Council in 1943 and states: "The professional occupational designation 'sanitary engineer' shall apply to a graduate of an approved scientific or engineering school, who has fitted himself by suitable training or study and by experience, to conceive, or design, or operate, or direct, or manage engineering works, (a) developed as a whole or in part for the protection and promotion of the public health, or (b) capable of injuring the public health through faulty conception, or design, or construction, or operation, or management. Ability to identify, evaluate, and explain in terms of their sanitary or public health implications those factors connected with such engineering works that will prevent injury to health or that will promote health, in addition to the ability to conceive, or design, or operate, or direct, or manage such works, shall constitute the basis of differentiation between individuals qualified as sanitary engineers and individuals qualified only as civil, mechanical, electri-

* Presented at the Civil Engineering Division conference of the Annual Meeting, Austin, Texas, June 16, 1948.

cal, mining, or chemical engineers. In exceptional circumstances, eight years of suitable experience and study that give evidence of the acquisition of proficiency in the fundamental engineering sciences as well as in engineering technique, may be considered equivalent to graduation from an approved engineering school."

Programs of sanitary engineering activity will be carried forward by many agencies, and each agency will in turn tend to modify the type of sanitary engineering work undertaken under its sponsorship. As an attempt at classification, the following categories may be useful:

1. Design and Construction. Much of this work will be done by consulting engineers, although large corporations, water departments, and sewerage divisions of large cities may engage in this work. City engineers may engage in sewer extension work, and some state engineers will do design work for state institutions, etc.
2. Operation. This includes water, sewage and industrial waste disposal plant operation, primarily, and at present would not usually include small plants.
3. Public Health. This includes all sanitation control sponsored, promulgated, initiated, or conducted by public and private health agencies.
4. Industrial Hygiene. This includes the specialized operations concerning the engineering control of industrial environment engaged in by official agencies and by industrial concerns. This is sometimes termed "industrial sanitary engineering."

On the basis of this classification, sanitary engineering has become a broad field in itself, with various specialties which require quite distinctive training; consequently, it is difficult to define an education program which is satisfactory for all, but which is not too extensive. However, just as there are certain subjects which are accepted as basic to all branches of engineering, such as general chemistry, physics, mathematics through calculus, engineering drawing, English, elementary economics, statics and strength of materials, we believe that there are certain topics which are basic to all branches of sanitary engineering.

It is a recognized fact that many engineers in later life practice in a field of engineering other than that in which they took their undergraduate degree. It seems certain that of those who think they will specialize in sanitary engineering there will be some who will soon move into other fields. Likewise, some who feel certain that they will specialize in one phase of sanitary engineering may gradually work over into another phase. Hence, too narrow specialization should be avoided at all costs.

Basic Engineering

Every sanitary engineer should be adequately trained in the basic principles of engineering. Recently engineering curricula have been criticized as being too technical, so that there has been a trend toward including more of the socalled "humanistic-social" studies in engineering curricula. The Professional Education Committee Report of the A.S.C.E. for 1945 indicates that 20 per cent of the engineering curriculum is devoted to such studies. This may be insufficient to provide the required amount of public speaking, law and administration which engineers should have and probably cannot get in a four-year curriculum. At present there is little agreement on what should be included and how it should be taught. The conventional four-year curriculum has been so crowded that little specialization in the sub-divisions of the major fields of engineering is possible, or it has caused the four-year curriculum to be replaced by a five-year curriculum. We do not believe that a four-year curriculum (undergraduate) in sanitary engineering is desirable. If sufficient specialized work is given to justify a separate curriculum, then other essential courses must be omitted, resulting in a graduate whose training is too narrow and specialized, and who would be handicapped if he ever tried to work in any other field of engineering.

A consideration of the four general types of sanitary engineering work previously given indicates that no single undergraduate path to sanitary engineering is likely. In general, a sanitary option in civil or chemical engineering seems to be best, although civil, chemical, and mechanical engineering graduates may hope to enter the practice of sanitary engineering. It would be desirable for sanitary engineering electives to be selected in the fourth year and be continued in the fifth. Of course, a graduate of any other field of engineering may also qualify but more time will be required to complete his training. The civil engineering path appears to be generally preferable for Design and Construction; chemical engineering for Operation; and civil, chemical or mechanical engineering for Public Health and Industrial Hygiene.

Since the practicing sanitary engineer may not stay in any one field, the graduate who has completed the proposed program should be able to enter any phase of sanitary engineering, and with additional experience and study, be able to advance in his chosen field. As his basic training may be in any of the major fields of engineering, it is necessary to state minimum requirements in certain subjects which seem necessary for sanitary engineering, but which may not have been included in all undergraduate curricula. The semester hours credit suggested is considered about the minimum desirable. These subjects are as follows:

1. Surveying. An elementary course is desirable in all cases. Additional is needed for those in Design and Construction, and possibly in Public Health. (2–3 sem. hrs.)

2. Structures. All sanitary engineers should have basic knowledge of elementary structures in steel and concrete, while those in Design and Construction, and in Public Health should have a knowledge about equal to normally required in a civil engineering curriculum. (5 sem. hrs.)

3. Fluid Mechanics and Hydraulics. A basic knowledge of these subjects should be required of all sanitary engineers. (4–6 sem. hrs.)

4. Electrical Engineering. An elementary general course, emphasizing applications, should be required in all cases. (3–4 sem. hrs.)

5. Mechanical Engineering. An elementary course including heat engines and elementary thermodynamics should be required. (4 sem. hrs.)

6. Geology. A course in engineering geology is desirable. (3 sem. hrs.)

7. Engineering Economics. The subject matter of engineering economics should be required either in a separate course or worked into other courses.

8. Law, Contracts and Specifications. Information concerning these topics should be included in a separate course if not worked into other courses.

Specialized Instruction

Provided the student has a degree in engineering as well as training in the subjects listed above, specialized training should include the following subjects:

1. Bacteriology. A basic course, preferably with some emphasis on medical bacteriology. (Need not cover water and sewage applications if these are included elsewhere.) (Minimum, 3 sem. hrs.)

2. Sanitary Chemistry. Theory and practice of essential topics in quantitative, physical and biological chemistry as applied to water, sewage, etc., but need not include standard methods of analysis if covered elsewhere. (Minimum, 8 sem. hrs.)

3. Sanitary Engineering Laboratory. Standard methods of analysis of water, and sewage, principal routine plant control tests, and their significance. May be combined with other courses. (Minimum time, 2 sem. hrs.)

4. Water Supply, Sewerage and Drainage and Design. Should include hydrology and aquatic biology or limnology if not included elsewhere. (Minimum, 5 sem. hrs.)

5. Water Purification and Sewage Treatment (theory and design). (Minimum, 6 sem. hrs.)

6. Public Health. Includes epidemiology, vital statistics, public health law, public health administration, environmental sanitation including rural, general and industrial, entomology and parasitology. The material indicated here would be of an introductory nature, intended to orient the student into the whole field of sanitation and public health. Some of this subject matter might be included in other courses. Beyond this basic material, additional training in some of the topics would be needed to provide for specialization. (Minimum time, 6–8 hours.)

The subjects listed above are believed to provide the basic foundation upon which sanitary engineering is built. As listed, it is not intended that the 6 topics should be used as titles of specific courses, but rather that the subject matter should be included in the courses provided. The minimum semester hours credit is suggestive, and should not be considered a rigid requirement, although in general, more rather than less time would be desirable. Students who have opportunity to include more than this minimum amount of work will frequently wish to specialize in some phase of sanitary engineering, and advanced courses in the above subjects should normally be available of this purpose.

No attempt is made in this report to suggest a curriculum in sanitary engineering, nor to indicate just how the suggestions detailed above should be carried out. It is believed that the programs requires more than four years, but whether a basic four-year curriculum should be followed by a fifth year leading to a second bachelor's degree in sanitary engineering or to a master's degree, or a five-year curriculum be worked out, is left to the individual college.

If the fifth year is to be considered a graduate year, which would seem to be the normal procedure, then the designation of the degree may be of importance. In most colleges, sanitary engineering is administered by the civil engineering department. To those who have previously received a bachelor's degree in civil engineering, it would be possible to arrange a satisfactory year's work, incorporating the minimum requirements previously stated, and to award the student a master's degree in civil engineering. For many others, who have an undergraduate degree in another branch of engineering, the college may be unwilling to grant a master's degree in civil engineering unless the student takes a number of undergraduate civil engineering courses which are not necessary for sanitary engineering. This situation must be recognized by those colleges which intend to give graduate work in sanitary engineering, and it would appear that in these cases the master's degree should be given either without designation, or it should be a master's degree in sanitary engineering. Since many civil engineering graduates will be so deficient in bacteriology, chemistry, and in public health as to require this work in the graduate year, even they may not qualify for the master's degree in civil engineering in one year unless they omit essential sanitary engineering requirements. Hence, it appears definitely desirable that the recognized master's degree should be one in sanitary engineering, and not in some other branch of engineering. Normally, with proper undergraduate electives, the student should be able to complete the above minimum program, and take some additional work, possibly allowing limited specialization in one of the sub-divisions of sanitary engineering.

If the master's degree in sanitary engineering is to be granted for the fifth year's work, it is important that graduate credit be allowed for work in chemistry, bacteriology and biology. These subjects should be presented objectively to meet the use need of the engineer, and at a graduate concentration level. An interested graduate student can learn more biology in a month than a mildly

interested undergraduate will absorb in a semester.

For those who intend to specialize in public health, even the above program will often prove to be deficient. A sixth year's work leading to the degree of Master of Public Health will be desirable to climax the training program by rounding out his foundations in biometry, epidemiology, bacteriology, public health administration, environmental sanitation and such specialty courses as industrial hygiene engineers might require.

In conclusion, it must be recognized that there are and will be exceptions to any program which may be proposed. Most sanitary engineers now in the field have not had as complete basic training as suggested here—they have learned by experience and private study. Some years ago the same was true in some of the other branches of engineering. Nor does the proposed program include all the subjects which many persons feel are essential for sanitary engineering—they merely include a foundation upon which to build.

This report must not be considered to be in final form. Rather it needs to be constantly reviewed in the light of experience and modified where change is indicated. It should be circulated among sanitary engineers of all categories for their comments. This should be one of the projects of the committee for the coming year.

Another matter which may warrant consideration during the coming year is the question of whether any type of field training program or internship is desirable in connection with the master's degree in sanitary engineering, such as is now being provided to some extent in public health.

The question of how the above program may be formulated into a working program has been asked, and it is possible that something more definite in the form of a suggestive outline of work, possibly for the fourth and the fifth (graduate) year may be desirable, although no attempt should be made to make this so detailed as to make it appear that the program should become completely standardized.

Still another matter for consideration is the question of just what facilities in the way of faculty and laboratories, etc., should be available in a department which is offering the master's degree in sanitary engineering. As yet, graduate work in engineering has not been accredited, but it seems likely that it will be, and this committee may well aid in this program in so far as sanitary engineering is concerned. For the Master of Public Health degree, accrediting is already a fact through the American Public Health Association.

Before closing this report, attention should be called to a committee of the Engineering Section, American Public Health Association, which has the task of attempting to arrange a conference of instructors of environmental sanitation. Mr. Ellis Tisdale, U. S. Public Health Service, Atlanta, is chairman of this committee. If successful, it will still be some time before such a conference is held, and it should be of interest to all sanitary engineering instructors.

Respectfully submitted,

Earnest Boyce
Kenneth W. Cosens
Harold B. Gotaas
William T. Ingram
George W. Reid
Gilbert H. Dunstan, *Chairman*

Report of the Committee on Industrial Hygiene, Safety and Fire Prevention

This committee was appointed during the summer of 1946, and held its first meeting at Minneapolis in June, 1947.

The objectives of the committee as given in the report submitted at this meeting were:

(1) The creation of a realization of the need for an understanding of the principles of industrial hygiene, safety and fire prevention on the part of engineering graduates.
(2) The promotion of interest on the part of faculty members in undertaking to meet this need.
(3) Providing as much assistance as possible to faculty members in giving such instruction.

The committee desires to avoid duplicating work done by other committees or organizations, hence has been in contact with various groups, such as the American Society of Mechanical Engineers, American Society of Safety Engineers, American Industrial Hygiene Association, National Fire Protection Association, National Safety Council, National Board of Fire Underwriters, National Conservation Bureau, American Automobile Association, National Education Association, etc. This committee will try to make known to instructors such of the activities of these groups as should be helpful in promoting the objectives of the committee.

In order that engineering graduates be prepared not only for the technical phases of engineering, but also so that they will be able to assume their proper share of the responsibility for a safe and healthful working and living environment, it is essential that engineering students receive some knowledge of safety, industrial hygiene, and fire prevention. Two methods of accomplishing this seem possible.

The first method is to introduce into each engineering course appropriate references and material relating to safety, industrial hygiene and fire prevention. In general, this should not appreciably change existing courses, but the student should be far better trained than he often has been in the past. This method would reach all students, although it does not give them complete training in health and safety. It requires some effort on the part of instructors, and some instructors will need assistance from safety engineers and others in determining how best to teach safety and industrial health. This method will be aided greatly if textbook publishers will request authors to work into their new books and revisions of existing books appropriate material on safety, industrial hygiene and fire prevention. The committee should attempt to secure this cooperation from publishers.

The second method is to provide senior elective courses in safety, industrial hygiene and fire prevention. While such courses may be required of a few students, most graduates are unlikely to take them due to lack of time. They have real value in permitting a systematic presentation of the subject matter, and should be of even greater value to students who have had some contact with applications of the subject in previous courses as suggested above.

In Industrial Safety, there are a number of existing textbooks which may be useful, and at present the American Society of Safety Engineers has a committee working on a detailed syllabus for such a course. It had been hoped that the chairman of this committee, Mr. J. C. Stennett, would present a discussion of this on the program to follow, but he is unable to be present, and Prof. W. N. Cox, a member of that committee will present this material as well as his own prepared talk.

There are several books which may form the foundation for a course in Industrial Hygiene, but at present there are not textbooks for a course in Fire Prevention, although there is a brief outline for such a course prepared by a committee of the National Fire Protection Association.

There is appended to this a brief and incomplete list of books which may be useful.

At last year's meeting it was suggested that an attempt be made to have a speaker on safety for one of the general sessions at this meeting of the Society. No such talk appears on the program. It is therefore recommended that this suggestion be transmitted to the officers, with the hope that it may be possible to arrange such a talk for next year's meeting.

This meeting is a joint meeting with the Civil Engineering Division and it is proposed that similar joint meetings with other divisions be held in the future. Since the syllabus for a course in Industrial Safety should be completed before the next meeting, it seems desirable that next year's meeting be with either the Industrial Engineering Division the Mechanical Engineering Division, since such a course would normally be given by one of these departments.

We are trying out on a limited scale an idea which may prove useful. Ten large envelopes with literature on safety, relating particularly to civil engineering, are available for distribution to interested civil engineering instructors. This material has come from the National Safety Council, U. S. Labor Department, and National Board of Fire Underwriters. It is far from complete, but it may be suggestive and hence useful in supplying suggestions for material to be worked into existing courses. Instructors taking these will be asked to report on whether the material has been of any use. If so, other kits may be prepared in the future.

Suggested Books

Safety:

1. Industrial Safety, edited by Roland P. Blake. Prentice-Hall.
2. Applied Safety Engineering, by Berman and McCrone. McGraw-Hill Book Co.
3. Industrial Accident Prevention, by H. W. Heinrich. McGraw-Hill Book Co.
4. Occupational Accident Prevention, by Judson and Brown. John Wiley & Sons.
5. Foremanship and Safety, by C. M. MacMillan. John Wiley & Sons.
6. Safety Supervision, by V. G. Safety. McGraw-Hill Book Co.
7. Education for Safe Living, edited by Stack and Siebrecht. Prentice-Hall.
8. Publications of the National Safety Council, Chicago, Ill.

Industrial Hygiene:

1. Industrial Health Engineering, by Brandt. John Wiley & Sons.
2. The Industrial Environment and Its Control, by J. M. Dalla Valle. Pitman.
3. Manual of Industrial Hygiene, edited by W. M. Gafafer. Saunders.
4. Essentials of Industrial Health, by C. O. Sappington. J. B. Lippincott.

Fire Prevention:

No text books.

1. Fire Protection Handbook, Crosby-Fiske-Forster. National Fire Protection Assoc.
2. Chemistry in Relation to Fire Risk and Fire Prevention, by A. M. Cameron. Pitman Pub. Co.
3. Recommended Building Code, National Board of Fire Underwriters, 85 John St., New York City.

Submitted by the Committee

G. H. Dunstan, *Chairman*
Wayne R. Hughes
Wm. N. Cox
L. M. K. Boelter
R. A. Moyer
R. A. Moyer
C. A. Norman
G. O. Pierce
John Roche

Pan American Engineering Congress

Engineering in the Service of Peace

Engineering in the Americas today needs a "town meeting" for the expression of its common points of view, for the unification of its plans, for the joint study of the great problems which confront it—problems which relate to the general welfare and to peace among nations—and for the achievement of personal contact and direct links among the engineers of the American community.

To achieve these objectives, the SOUTH AMERICAN UNION OF ENGINEERING ASSOCIATIONS (USAI) decided to hold, in cooperation with engineering associations throughout the Americas, the FIRST PAN AMERICAN ENGINEERING CONGRESS, from July 15 to 24, 1949, in Rio de Janeiro, to be preceded by a meeting of engineers in São Paulo from July 9 to 13. S. S. Steinberg, Dean of the College of Engineering, University of Maryland, and Vice President of the ASEE, is Chairman of the Committee of the Engineer's Joint Council for United States participation in the Congress.

The technical Agenda of the Congress includes the following subjects:

Transportation and Communications:

a. Railway Transportation
b. Highway Transportation
c. Maritime Transportation
d. River and Lake Transportation
e. Air Transportation
f. Tele-communications
g. Postal Services

Construction:

a. Foundations
b. Structures
c. Building Construction

Power:

a. Hydraulic Power
b. Fuel
c. Electric Power

Urban and Rural Engineering:

a. Urban Engineering
b. Rural Engineering

Sanitary Engineering:

a. Water Supply
b. Storm Waters
c. Pollution and Self-purification of Streams, Lakes and Bathing Beaches
d. Sewerage
e. Economy of Urban Water and Sewerage Systems
f. Disposal of Wastes
g. Hospitals and Cemeteries
h. Rural Sanitation

Industrial Engineering:

a. Metallurgy
b. Mechanical Industry
c. Extractive and Processing Industries
d. Chemical Industries

Mining Engineering and Geology:

a. Mining Engineering
b. Geology

Teaching of Engineering
Miscellaneous

THE T-SQUARE PAGE

Officers
H. C. Spencer
O. W. Potter
T. T. Aakhus
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R. T. Northrup
R. P. Hoelscher

Devoted to the Interests of Engineering Drawing

W. J. Luzadder, *Editor*
Purdue University

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The Importance of Technical Sketching to the Practicing Engineer

By H. H. KATZ

Director, Technical Drawing and Engineering Department, Technological Division, Allied School of Mechanical Trades

Technical sketching (freehand pictorial and orthographic drawing) is intended to *supplement* the mechanical type of representation—thereby expanding the engineer's means of graphical expression. It is also useful for developing observation, retentativeness, and imaginative thought.

Technical sketching offers a direct method for drawing rapid freehand sketches, executed well enough to instill in the reader a sense of realism and confidence, but executed with emphasis on function rather than beauty of technique. A methodical approach to technical sketching will also open new avenues to graphical expression. For example, this flexible branch of engineering drawing allows us to get to the inside of the object, to do a little more "surgery" on the drawing board than is possible by conventional sectioning. Aside from its many productive applications in which the engineer must take part (often whether he desires to or not), technical sketching will expand the engineer's working vocabulary in the ratio of "one picture to 10,000 words."

In a broad sense, industrial technical sketches are applied as follows:

(1) As a means to assist in the creation of the idea or design
(2) As a means to assist in the development of the design
(3) As a means to facilitate a change in the machine or structure during production or
(4) As a means to help visualize engineering subject matter

Sketching fosters creativeness and helps to develop individual ingenuity. Ideas, so essential to the engineer and designer, when recorded upon conception, may prove of future value on the drawing board; when entrusted to memory, they may slip by and never be employed.

The function of the mechanical drawing is to impart description, specifications, and instructions to the shop so that a three-dimensional object may be manufactured. Obviously, a three-dimensional mental picture must first be conceived by the designer. It is in this initial stage—searching, experimenting—that the designer records his thoughts by the medium of rapid sketches. It is in the sketch that confusing complications may be relieved—and a tangible hold on the idea can be established; the designer now has an opportunity to evaluate, analyze, and coordinate the essential of the idea. "Thinking" with the pencil also adds a unique stimulus to the imagination so necessary to inventive development.

Development sketches include the *planning sketches* which consist of simple view arrangements, sections, details, sub-assemblies, etc., made as a preliminary scheme for determining and placing of proper views for complete manufacturing information in the mechanical drawing. The flexibility of the sketching medium allows for a variation of shape description and dimensioning arrangements in the most rapid manner. This basic thinking and working out of problems before a mechanical drawing begins, hastens the solution and considerably cuts engineering drawing costs.

In *breakdown sketches* the component parts of an assembly or installation may be "exploded," that is separated on their fastening or assembly axes. This type of sketch helps to gain an exact over-all assembly visualization for the engineer.

The liaison engineer is often called upon to give authorization for manufacture, by means of a pictorial or orthographic sketch. A sketch of this type must contain all the characteristics of a production drawing in regard to drawing number, bill of material information, specification of processes and all the dimensions, notes, and instructions necessary for manufacture. It is difficult to imagine a liaison engineer performing his work without the ability to execute technical sketches.

In the field of engineering sales technical sketching becomes of acute importance. A finished sketch or plan, prepared in the engineering office, is often the basis on which the potential client accepts or rejects a job.

Some clients are unable to visualize, or demand modifications according to their own specifications. The inadequacy either of written or oral description of technical engineering expression or variations in design present major problems to the sales engineer in these and other circumstances. Such problems can be settled easily with technical sketches drawn directly on the drawing under discussion. The sketches should be drawn in the presence of the client so that he can visualize the result readily and satisfactorily. This saves considerable time for the Engineering Department and client, and lessens the liaison time and effort which, when excessively drawn out, often prove fatal to the securing of the potential contract.

College Notes

Approximately six million dollars in cash and securities has been given to the **Carnegie Institute of Technology** by The W. L. and May T. Mellon Foundation to establish the nation's first graduate school of industrial administration. In making the announcement, President Robert E. Doherty revealed that at least one million dollars of the Foundation's gift will be used to erect a building on the Tech campus and about five million to endow the new school.

Cledo Brunetti, former chief of the engineering electronics section in the U. S. Bureau of Standards, will join the staff of **Stanford Research Institute** January 1 as associate director. During World War II Dr. Brunetti had a leading part in the development of the radar-guided bomb and of the radio-proximity fuse, one of the major secret weapons of the war. The proximity-fuse, which enables shells to explode at variable ranges from targets through radio waves, downed thousands of enemy planes.

Establishment of a Division of Engineering Mechanics in the School of Engineering was announced today by **Stanford University.** The division, which begins its activities in January, will administer a graduate program and grant masters and doctoral degrees in engineering mechanics, and will also coordinate sponsored research in this field.

The division will be administered by an executive committee of faculty members headed by **Stephen P. Timoshenko.**

Establishment of two national centers of rocket and jet propulsion study and research, to be located at **Princeton University** in the east and **California Institute of Technology** in the west, was announced jointly by Harry F. Guggenheim, president of The Daniel and Florence Guggenheim Foundation, Dr. Harold W. Dodds, president of Princeton University, and Dr. Lee A. DuBridge, president of California Institute of Technology. Hailed as a major stimulant to the development of rockets and jet propulsion and one of the most striking postwar developments in engineering education, the new institutions will be known as Daniel and Florence Guggenheim Jet Propulsion Centers. Each will provide facilities for post-graduate education and research in jet propulsion and rocket engineering. They will emphasize particularly the development of peacetime uses of rockets and

jet propulsion. The Daniel and Florence Guggenheim Foundation has underwritten the two Jet Propulsion Centers for a period of seven years, and has appropriated $500,000 for that purpose. These funds are to be used to pay salaries of professors, stipends of graduate students, and similar expenses. Necessary buildings and equipment are to be provided by the universities.

Nephi Albert Christensen, formerly dean of engineering at Colorado State College, was appointed director of the School of Civil Engineering at **Cornell University.** He succeeds Dr. William Lindsay Malcolm, who died last January.

Since 1938 Dr. Christensen has been dean of engineering at Colorado State College and chairman of the engineering division of the Colorado Agricultural Experiment Station. On leave during 1942–45, he served successfully as chief engineer of the Ballistics Research Laboratory and chief of the research branch of the Rocket Research Division at the Ordnance Research and Development Center, Aberdeen, Md.

Acting on the recommendation of Dr. Karl T. Compton, president of the **Massachusetts Institute of Technology** since 1930, the corporation has elected **Dr. James Rhyne Killian, Jr.,** vice president since 1945, to be the next president of the Institute. Dr. Compton is serving as Chairman of the Board and also is Chairman of the Research and Development Board of the National Military Establishment in Washington. Dr. Killian, who is 44 years old, will be the first graduate of the institution to have the honor of becoming its president. The inauguration will take place on Saturday, April 22, 1949.

Plans for the Fourth Hydraulics Conference, to be held at the **University of Iowa** June 12–15, have just been announced by the Iowa Institute of Hydraulic Research. The program will include five technical sessions, a guided tour of the new Institute facilities, and ample opportunity for informal gatherings. Thirteen correlated papers, which are now preprinted for distribution to conference registrants, will represent a symposium on present-day principles and methods of analysis. Following the conference the papers will be published as the successive chapters of a comprehensive volume on "Engineering Hydraulics."

. . . *theme for the year*

PARTNERSHIP WITH INDUSTRY

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	U. of Pittsburgh	April 22 and 23, 1949	R. C. Gorham, University of Pittsburgh
Illinois-Indiana	University of Notre Dame	May 14, 1949	R. J. Schubmehl, University of Notre Dame
Kansas-Nebraska	University of Nebraska		Linn Helander, Kansas State College
Michigan	Michigan State College	May 7, 1949	C. L. Brattin, Michigan State College
Middle Atlantic	U. S. Military Academy	May, 1949	R. T. Weil, Jr. Manhattan College
Missouri	Washington University	April 9, 1949	C. L. Wilson, Missouri School of Mines and Technology
National Capitol		May 14, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Oct. 14 and 15, 1949	C. J. Posey, State University of Iowa
Ohio	Ohio University	April 9, 1949	E. H. Gaylord, Ohio University
Pacific Northwest	Montana State College	June 16 and 17, 1949	E. W. Schilling, Montana State College
Pacific Southwest	University of California, Los Angeles	Dec. 28 and 29, 1948	Ralph Smith San Jose State College
Rocky Mountain	University of Denver	May, 1949	M. P. Capp, University of Denver
Southeastern	University of South Carolina	April 7, 8, and 9, 1949	J. E. Hannum, Alabama Polytechnic Institute
Southwestern	Southern Methodist University	April 15 and 16, 1949	H. C. Dillingham, Texas A. & M. College

Sections and Branches

A meeting of the **University of Detroit Branch** of the American Society for Engineering Education was held December 10, 1948. Father Quinn, Dean of College of Arts and Sciences, was the principal speaker on the subject "Objectives of the College of Arts and Sciences." He stated that a liberal arts program must have no vocational objective but must give the student a truly liberal education which disciplines and prepares his mind so that he has sound intellectual habits, is capable of understanding wisdom, and of forming good judgments. It must contain moral training. Such education should be given to the limit of the individual's capacity and occupies a lifetime of endeavor.

Northeastern University was host to the **New England Section** of the American Society for Engineering Education at its annual fall meeting on October 16, 1948. Chairman Tucker introduced James S. Thompson, National Treasurer of the Society, who brought greetings of the National Office. Walter J. Wohlenberg, recently appointed Dean at Yale University, extended an invitation to the New England Section to hold the fall conference of 1949 at Yale University. Officers elected for the following year include: C. E. Tucker, Chairman; W. E. Keith, Secretary; and E. R. McKee, Representative on the General Council.

The following conferences were held:

Chemical Engineering: "The Teaching of Physical Chemistry to Chemical Engineers," W. G. Parks; "Introductory Courses in Chemical Engineering," E. F. Thode.

Civil Engineering: "Teaching Reinforced Concrete Design in the Undergraduate Curriculum," J. H. Minnich, M. J. Holley, Jr.: "The Objectives of Instruction in Transportation Engineering," H. C. Archibald, R. H. Whitaker, W. L. Hyland.

Electrical Engineering: "Economic Selection in Engineering," J. R. Coffin; "The Significance of Engineering Costs in Manufacturing Industry," E. W. Butler.

Industrial Engineering: "What is Industrial Engineering?" J. A. Willard; "The Teaching of Production Control," E. A. Boyan.

Mechanical Engineering: "Electronic Courses for Mechanical Engineering Students," J. A. Hrones; "Education for a Profession," W. F. Ryan.

Drawing: "The Logic of Visualization," B. L. Wellman; "Drafting Horizons," E. N. Gelotte.

Engineering School Libraries: "The Library and the Technique of Research," V. D. Tate; "Some New Theories on Illustrated Lectures," P. Leslie; "Maintenance of Library-Faculty Relationships," H. G. Hauck; "Survey of Instruction in Library Technique in Engineering Schools," G. M. Snyder.

English and Humanities: "An Operational Approach to Freshman Compositions," G. A. Craig; "The Problem Method in Humanistic Studies," C. H. Gray.

Mathematics: "Advanced Calculus for Engineers," F. B. Hildebrand; "The Place of an Applied Mathematician in Engineering," P. Lecorbeiller.

Mechanics, Strength of Materials and Fluid Mechanics: "Work at the Alden Hydraulic Laboratory," L. J. Hooper; "Making Mechanics Interesting," J. P. Den Hartog.

Physics: "The Engineers' Council for Professional Development," A. Haertlein; "Can Standards be Administered in Physics?" S. S Ballard; "Physics Departments and Engineering Physics Curricula," C. E. Bennett.

Technical Institutes: "The Place of the Technical Institute School Graduate in Industry," J. A. Lunn, F. E. Coe.

The **Michigan Section** of the ASEE held its Annual Meeting on May 15, 1948, at the University of Michigan. Dean I. C. Crawford delivered the address of welcome, giving a brief history of the ASEE and its outstanding achievements.

Chairman W. J. Emmons introduced H. H. Armsby, Specialist in Engineering Education from the U. S. Office of Education, who presented a discussion of "Recent Federal Activities of Interest to Higher Education."

The slate of candidates, presented by Dean A. R. Carr, was accepted and a unanimous ballot was cast for it. As a result, the officers chosen were: Chairman, C. L. Brattin; Vice Chairman, H. M. Hess; Secretary-Treasurer, H. M. Dent; Michigan Representative on the National Council, C. A. Brown.

A resolution was adopted to support the nomination of Dean C. J. Freund for the National Presidency of the Society for the year 1948–49.

The Tenth Annual Business Meeting of the **North-Midwest Section** of the ASEE was called to order by Chairman F. L. Partlo.

G. Machwart, Chairman of the Committee on Invitation to the Dakota Colleges, was heard. The Committee recommended that the Dakota Colleges located in Grand Forks, Fargo and Brookings be allowed to join the North-Midwest Section of the ASEE. These schools are to act as a group in being host to the Dakotas with the first one being held at Brookings in 1955. The motion was passed.

The Nominating Committee suggested that the following men hold office for the next Annual Meeting: Chairman, C. J. Posey; Vice Chairman, E. W. Johnson; Secretary-Treasurer, J. M. Trummel; Board Members, G. Barker, A. Higdaw, S. L. Canterbury, G. M. Machwart. The secretary was instructed to cast a unanimous ballot for the above slate of officers.

It was thus decided to hold the next Annual Meeting on the campus of the University of Iowa in October, 1949.

The **Northwest Section** of the ASEE held its Annual Meeting at Corvallis Oregon, on April 23–24, 1948. Dean G W. Gleeson of Oregon State College presided. There was a discussion of "Teaching Problems of the New Instructor in Engineering" by M. R. Carstens, J. B. Morrison and H. N. Parkinson. Other speakers included:

A. A. Hemenway, "Today's Engineer and His World"; E. W. Schilling, "Choice of Subjects to be Included in an Engineering Curriculum"; N. F. Hindle, "Humanities in Engineering Curricula"; D. L. Masson, "Further Consideration of the Humanities in Engineering Education"; G. W. Gleeson, "A Different Viewpoint"; F. B. Watson, "Problems Confronting the Engineering Instructor"; J. W. Hurst, "The Young Instructor of Engineering Students."

The **Illinois-Indiana Section** of the ASEE convened on May 7–8, 1948, at the Illinois Institute of Technology. L. E. Grinter presided.

There was a panel discussion "The "The Broad Objectives of Engineering Education" in which J. J. Cavanaugh, F. L. Hovde, D. B. Prentice and H. T. Heald participated. Other speakers included:

"Teaching Thermodynamics and Fluid Flow," R. F. Larson, and R. C. Binder; "Follow-Through on Drawing in the Engineering Curriculum," H. C. Spencer, W. T. Hooper, C. D. Greffe and R. R. Raney; "Non-Technical Values in Engineering Education," R. G. Sturm, W. A. Hanley and J. F. Calvert; "Engineering Analysis in All Curricula," L. E. Grinter, C. O. Harris, H. A. Moench, R. S. Elliot, L. Stutzman and M. Golomb; "The Teaching of Dynamics and Design," P. G. Jones, L. T. Wyly and R. W. Jones.

The Fall Meeting of the **Allegheny Section** of the ASEE was held at West

Virginia University, Morgantown, West Virginia on October 15, 1948. W. A. Koehler was the presiding Chairman. A. B. Bronwell, Secretary of the ASEE, spoke on "The Breadth and Depth of the Graduate Program." Other speakers included:

"How to Recognize and Reward Good Instructors," H. P. Hammond; "The Training of Young Instructors," F. T. Mavis; "What Help I Would Like to Have Received," E. P. Nye. D. M. Griggieth, R. C. Gorham and D. T. Worrell discussed "Aids to Good Teaching."

The Fourteenth Annual Meeting of the Pacific Southwest Section of the ASEE was held at the **University of California** at Los Angeles on December 28–29, 1948. S. G. Palmer was presiding Chairman. F. Thomas and S. F. Duncan discussed "Widening Horizons of Engineering Education" and C. L. Taylor and W. J. Warren "Biotechnology." Other speakers included: H. P. Rhodes, H. R. Filson and W. Kassebohm on Technical Institutes; D. S. Clark, E. W. Morris, O. A. Israelsen, R. E. Vivian, R. Bainer, E. S. Dibble and H. W. Case on "Employment Outlook on the Pacific Coast"; Research discussions by J. Hobson, B. S. Mesick and R. D. Fisher; Teaching Techniques discussion by J. M. Pettit, H. B. Blodgett, M. L. Goral, T. T. Eyre and H. B. Langille.

. . . *theme for the year*

PARTNERSHIP WITH INDUSTRY

New Members

ABBOTT, FRANK, Instructor of Civil Engineering, Brooklyn Polytechnic Institute, Brooklyn, New York. E. J. Squire, C. A. Wright.

ACKER, DAVID D., Instructor of Mechanical Engineering, Rutgers University, New Brunswick, New Jersey. M. T. Ayers, M. B. Moore.

AMUNDSON, NEAL RUSSELL, Associate Professor of Chemical Engineering, University of Minnesota, Minneapolis, Minnesota. E. L. Piret, N. H. Ceaglske.

ARMSTRONG, WILLARD PATTERSON, Assistant Professor of Chemical Engineering, Washington University, St. Louis 5, Missouri. D. F. Chamberlain, L. E. Stout.

ARNOLD, HENDRICK JACKSON, Assistant Professor of Electrical Engineering, University of Arkansas, Fayetteville, Arkansas. G. F. Branigan, N. W. Barnette.

AVERITT, WILLIAM KENT, Instructor of Chemical Engineering, Southwestern Louisiana Institute, Lafayette, Louisiana. G. G. Hughes, F. W. Zur Burg.

BAILEY, THOMAS RICE, Instructor of Electrical Engineering, University of Louisville, Louisville, Kentucky. M. G. Northrop, H. H. Fenwick.

BEAUCHAMP, JAMES MERCER, Instructor of Mechanical Engineering, Lehigh University, Bethlehem, Pennsylvania. T. T. Holme, M. C. Stuart.

BEZANSON, WARREN B., Instructor of English, University of Maryland, College Park, Maryland. C. A. Brown, S. S. Steinberg.

BJORK, JOHN ARTHUR, Instructor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts. M. L. Price, B. L. Wellman.

BLACK, EARL D., Instructor of Drawing and Design, General Motors Institute, Flint, Michigan. H. M. Dent, C. A. Brown.

BOGARDUS, FREDERICK J., Instructor of Machine Design, Purdue University, Lafayette, Indiana. E. S. Ault, J. B. Lusk.

BOLT, CHARLES D., Assistant Professor of Man. Engineering, Texas A. & M. College, College Station, Texas. Jack CoVan, S. A. Wykes.

BORKERT, JOHN J., Instructor of Engineering, Purdue University, Lafayette, Indiana. M. E. Gyte, D. C. Metz.

BOROWIK, ALBERT, Associate Professor of Engineering, Villanova College, Villanova, Pennsylvania. J. S. Morehouse, A. B. Bronwell.

BRAY, WILLIAM GLEDHILL, Instructor in Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, New York. N. P. Bailey, G. K. Palsgrove.

BROWN, DALE H., Instructor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, New York. J. G. Fairfield, M. A. Cook.

BRUNE, ARTHUR WILLIAM, Instructor of Civil Engineering, Washington University, St. Louis, Missouri. A. W. Brust, J. W. Hubler.

CALABRESE, GIUSEPPE O., Professor of Electrical Engineering, New York University, New York, New York. Philip Greenstein, David B. Porter.

CAMPBELL, RICHARD BARRIE, Engineer, Physical Plant, Purdue University, Lafayette, Indiana. J. N. Arnold, Maurice Graney.

CAMPBELL, THOMAS HERBERT, Assistant Professor of Civil Engineering, University of Washington, Seattle, Washington. F. H. Rhodes, A. B. Bronwell.

CANAN, SAMUEL W., Assistant Professor of Electrical Engineering, Villanova College, Villanova, Pennsylvania. J. S. Morehouse, J. B. Clothier.

CARROLL, GEORGE A., Professor of Social Studies, Case Institute of Technology, Cleveland, Ohio. O. M. Stone, G. A. Nyerges.

CASTLE, DREW WILLIAM, Instructor of G.E.D., Joliet Junior College, Joilet, Illinois. E. C. Douglas, A. B. Bronwell.

CHAMBERS, WILBUR W., Instructor of Mathematics, Purdue University, Indianapolis, Indiana. J. N. Arnold, A. K. Branham.

CHAPMAN, HARRISON, Lecturer in Chemical Engineering, Melbourne Technical College, Melbourne, Australia. R. N. Shreve, J. M. Smith.

CIUZLYS, JURGIS, Instructor of Mechanical Engineering, Indiana Technical College, Fort Wayne, Indiana. I. A. Planck, R. C. Ruhl.

CLARK, JAMES GORDON, Associate Professor of Civil Engineering, University of Illinois, Urbana, Illinois. W. L. Collins, W. C. Huntington.

CLARK, WILLIAM CURTIS, Instructor of Civil Engineering, University of Arkansas, Fayetteville, Arkansas. G. F. Branigan, G. P. Stocker.

CLEMENS, GEORGE J., Assistant Professor of Drawing, City College of New York, New York, New York. G. C. Autenreith, W. L. Stork.

COBB, ARNOLD COLVIN, Assistant Professor of Engineering, University of Illinois, Chicago, Illinois. C. J. Freund, A. B. Bronwell.

COGGESHALL, FREABORN PIERCE, Assistant Professor of Civil Engineering, Pennsylvania Military College, Cresson, Pennsylvania. Leo Blumberg, Frank L. Martin.

COLE, RICHARD H., Lecturer in Mechanical Engineering, Northwestern Technological Institute, Evanston, Illinois. R. G. Bigelow, B. H. Jennings.

COMASSAR, SEYMOUR, Instructor of Mechanical Engineering, Syracuse University, Syracuse, New York. James S. Rising, J. A. King.

CONWELL, WILLIAM A., Instructor of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pennsylvania. J. W. Graham, L. M. Laushey.

COONS, STEVEN ANSON, Instructor of Graphics, Massachusetts Institute of Technology, Cambridge, Massachusetts. J. T. Rule, D. P. Adams.

CORRIGAN, GLEN LEE, Professor of Petroleum Engineering, Louisiana Polytechnic Institute, Ruston, Louisiana. B. M. Aldrich, R. R. Irwin.

CORY, ARTHUR M., Instructor of English, University of Texas, Austin, Texas. J. A. Walter, W. T. Conklin.

CRAMER, CARL, Instructor of General Engineering, Purdue University, Lafayette, Indiana. J. N. Arnold, A. K. Branham.

CRAMER, GLENN EVERETT, Instructor of Design, University of Illinois, Chicago, Illinois. J. C. Chaderton, R. E. Kennedy.

CREWE, GEORGE FRANKLIN, Instructor of Chemical Engineering, West Virginia University, Morgantown, West Virginia. W. A. Koehler, H. V. Fairbanks.

DAUGHERTY, VONROY, Assistant Director, Technical Extension Division, Purdue University, West Lafayette, Indiana. Maurice Graney, D. C. Metz.

D'AVINO, RALPH FRANCIS, Assistant Professor of Electrical Engineering, Pennsylvania Military College, Cresson, Pennsylvania. Leo Blumberg, F. L. Martin.

DE LUCA, EDWARD DONALD, Associate Professor of Administrative Engineering, Pratt Institute, Brooklyn, New York. H. R. Beatty, N. S. Hibshman.

DEPTULA, ALFRED R., Instructor of Mechanics, Fenn College, Cleveland, Ohio. Samuel Ward, S. M. Spears.

DEVANEY, AMOGENE F., Associate Professor of Engineering, Amarillo College, Amarillo, Texas. A. J. Lynn, Fred W. Sparks.

DIXLER, DANIEL S., Instructor of Chemistry, Pratt Institute, Brooklyn, New York. A. W. Luce, K. E. Quier.

DONAHUE, THOMAS J., Professor of English, Polytechnic Institute of Brooklyn, Brooklyn, New York. E. J. Squire, C. A. Wright.

DUCKER, WILLIAM LYON, Professor of Petroleum Engineering, Texas Technological College, Lubbock, Texas. J. H. Murdough, G. A. Whetstone.

DURYEA, DAVID W., Instructor of Mechanical Engineering, Trenton Junior College, Trenton, New Jersey. S. P. Owen, L. A. Carver.

EDSON, CHARLES GRANT, Assistant Professor of Industrial Design, University of Florida, Gainesville, Florida. H. E. Schweyer, W. C. Ebaugh.

EMERSON, EDWARD DONALD, Assistant Professor of Mechanical Engineering, University of Massachusetts, Amherst, Massachusetts. P. D. Swenson, J. B. Longstaff.

ERNST, EDWIN HENRY, Instructor of English, Purdue University, Indianapolis, Indiana. J. N. Arnold, A. K. Branham.

FINZI, LEO A., Associate Professor of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pennsylvania. E. M. Williams, D. W. Ver Planck.

FISHER, JOHN C., Instructor of Electrical Engineering, University of Buffalo, Buffalo, New York. C. M. Fogel, A. J. Kamm.

FLAKE, GOLDEN, Instructor of Physics, Purdue University Extension, Indianapolis, Indiana. J. N. Arnold, A. K. Branham.

Ford, Lee H., Supervisor Education Section, International Harvester Company, Chicago, Illinois. C. J. Freund, A. B. Bronwell.

Fort, Benjamin Barrett, Instructor, Technical Institute, Purdue University, Indianapolis, Indiana. J. N. Arnold, Maurice Graney.

Froomkin, Norman G., Assistant Professor of Mechanical Engineering, Pennsylvania Military College, Cresson, Pennsylvania. Leo Blumberg, F. L. Martin.

Gallaway, Bob Mitchell, Assistant Professor of Civil Engineering, Texas A. & M. College, College Station, Texas. C. E. Sundstedt, R. L. Peurifoy.

Gelinas, Maurice Edward, Instructor of Engineering, Lowell Textile Institute, Lowell, Massachusetts. Milton Hindle, A. E. Wells.

Georgi, Charles O., Instructor of Civil Engineering, Villanova College, Villanova, Pennsylvania. J. J. Gallen, J. S. Morehouse.

Gilbert, Merton Lawrence, Assistant Dept. Chairman, Product Service, General Motors Institute, Flint, Michigan. C. A. Brown, H. M. Dent.

Gleekman, Lewis Wolfe, Assistant Professor of Chemical Engineering, University of Delaware, Newark, Delaware. Ralph W. Jones, Howard K. Preston.

Goetz, Arthur William, Director, School of Leather and Tanning Technology, Pratt Institute, Brooklyn, New York. A. W. Luce, K. E. Quier.

Goff, Ira Nathan, Assistant Professor, Technical Extension Division, Purdue University, Lafayette, Indiana. Maurice Graney, A. K. Branham.

Gould, Arthur Freeman, Assistant Professor of Mechanical Engineering, Lehigh University, Bethlehem, Pennsylvania. Thomas T. Holme, M. C. Stuart.

Green, James W., Professor of Electricity, U. S. Military Academy, West Point, New York. B. W. Bartlett, William Allan.

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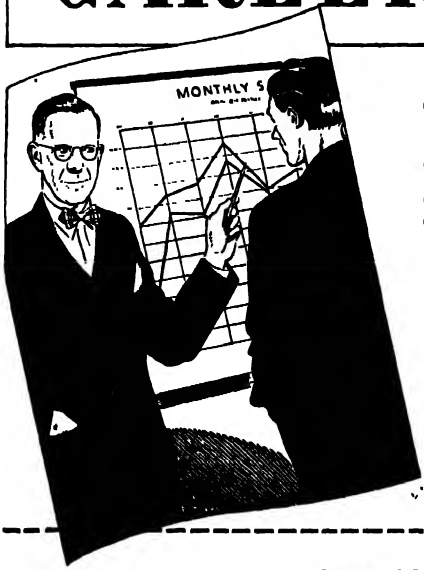

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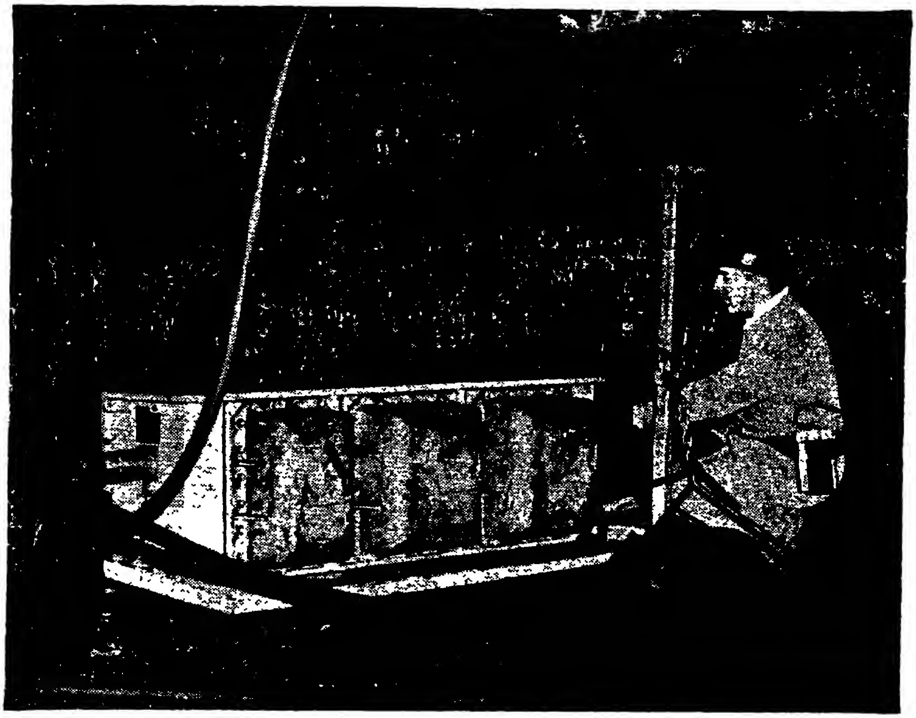

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Troy, N. Y.—June 20–24, 1949

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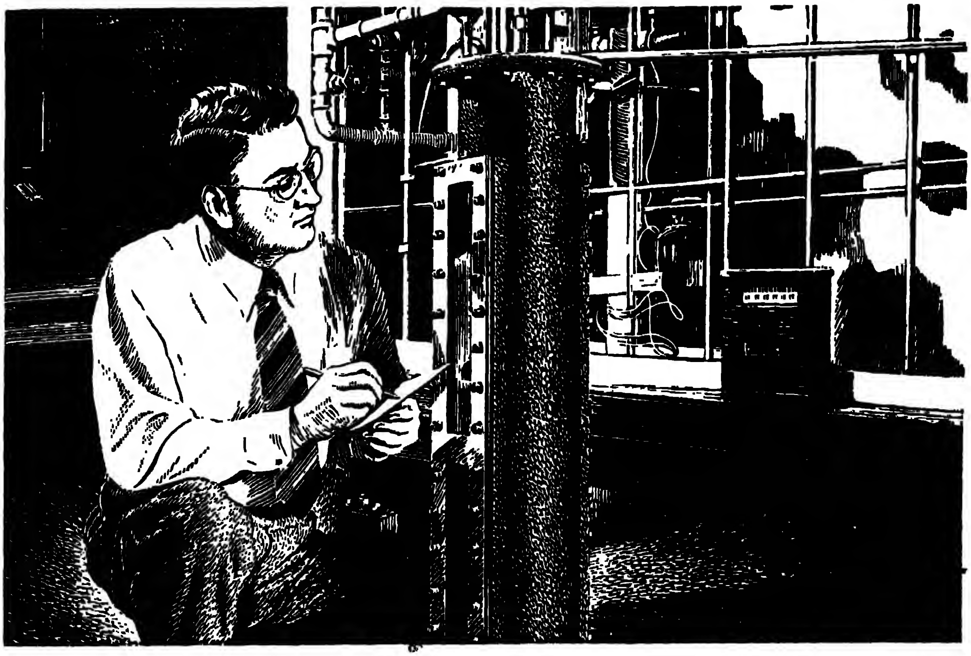
Other Wiley books on page 14



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It also becomes a "super-wetting" agent, meaning it will creep up a container's sides, flow over the edge.

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These are some of the facts of cryogenics—the study of low-temperature phenomena—into which a group of young General Electric scientists are directing their investigations.

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Educational Goals

By JAMES R. KILLIAN, JR.

President, Massachusetts Institute of Technology

In a recent Town Meeting of the Air devoted to the subject, "Are We Educating for the Needs of Modern Man?" I suggested that American education has the following goals:

First, we must give an understanding of our American heritage and of the sacredness of individual liberty in a free society.

Next, we must prepare men to grow in moral and spiritual stature. Our people must not only be literate; they must harness literacy to ideals and to a sense of the first rate. We must follow the precepts of the philosopher, Whitehead, that "moral education is impossible without the habitual vision of greatness."

Third, we must prepare men to be skilled and creative in their share of the world's work.

In our engineering schools we, of course, are primarily concerned with this third objective. Our function in the over-all American educational scene is to educate specialists who are able to put science to work for useful purposes. If we are to do this job adequately, I am convinced that we must provide more general education in the undergraduate curriculum, more even than was recommended by the report of the SPEE committee on "Engineering Education after the War."

If we are to attain this goal, we can anticipate less and less specialization in the undergraduate years. While preserving the motivation that comes from having specific courses of study, such as electrical engineering or mechanical engineering, in the undergraduate program, we must anticipate pushing into the graduate years some of the more specialized work. Our undergraduate subjects can thus be devoted to the basic content of engineering science. I would define the undergraduate engineering program of the future as one that provides a general education with the emphasis on science and engineering, rather than a specialized training with a small amount of general education.

Our institutes of technology are not unique in having to broaden their base. In the past two decades, the universities and liberal arts colleges have all been struggling with the need to provide a common core of studies which will contribute toward a man's effectiveness as an individual and a citizen, regardless of his occupation.

In rounding out their programs, the liberal arts colleges have recognized the educational value of the discipline, rigor, and motivation inherent in the engineering curriculum and they have sought to find equivalents. In turn the engineering colleges, while prizing and preserving these advantages, have been adopting into their curriculum more of the common core studies recognized in the liberal arts colleges. Thus the two programs have benefited one another.

As we seek to broaden the education of the specialist, we must at the same time be careful to avoid overscheduling and overfeeding him. The engineering schools have always been proud of their reputation for requiring hard work of their students. I hope they hold fast to

that reputation. But students need not only to meet rigorous requirements; they need also opportunities to reflect, to develop the intellectual maturity that comes only from self-education under adequate stimulus. The students who are studying to be professional men need time to be resourceful, to develop judgment, to acquire a broad margin to their careers. They need time to avoid what Veblen called "trained incapacity."

I suggest that these are some of the long-term considerations which will affect policy in our engineering institutions.

Sections and Branches

A meeting of the Missouri Section of the A.S.E.E. was held at Washington University in St. Louis on April 9. At this meeting, officers were chosen as follows for 1950: Chairman, C. M. Wallis; Vice-Chairman, A. W. Brust; Secretary, E. W. Carlton; for the General Council, R. Z. Williams.

C. L. Wilson presided at the General Meeting, which included addresses by L. E. Stout and G. F. Branigan. Other talks and papers given included:

Chemical Engineering

W. T. Armstrong
R. A. Cooley
R. H. Lubbers
J. C. Chu
R. R. Cornwall
D. F. Chamberlain

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J. B. Pickel
R. T. Webb
D. L. Waidlich
C. T. Johnk
J. Zaborsky
J. W. Rittenhouse
G. G. Skitek

Engineering Drawing

E. Zellmer
R. Bleikamp
J. Senne

Humanities, Social Studies and English

S. H. Lloyd
R. M. Schmitz
J. J. Jelinek
V. Staudt

Mathematics and Physics

R. E. Newton
D. H. Erkiletian

Mineral Industries

O. R. Grawe
A. Legsdin
W. J. Knapp
W. A. Vine
H. L. Scharon

The meeting closed with an address by A. H. Compton, President of Washington University.

Partnership with Industry*

By C. J. FREUND

President of the Society and Dean of Engineering, University of Detroit

Last year President MacQuigg moved the headquarters of the Society to Evanston, and staged what was possibly the most successful membership campaign in the Society's history. The year before, President Croft reorganized the Society, and formally established its international relations. The year before that, President Rogers revised the constitution and by-laws. And so on. It has been a tradition in the Society for the officers each year to undertake some one project to make the Society better.

The officers have looked over the situation and have made "Partnership with Industry" the special objective for this year. They believe that the industries and the schools of engineering need to cooperate very much better; and that there should be more teamwork between the engineers in plant and field, and the teachers of engineering in the colleges and schools.

The officers realize that many other important and serious problems confront the Society, but they selected this problem for reasons which I shall try to explain in a moment.

There is, of course, considerable intercourse between engineers in the industries and the engineering teachers. Recruiting officials visit the colleges to interview seniors. Professors undertake research projects for sponsor industries and work hand in hand with engineers in plants and laboratories. Others in the faculties are consulting engineers for manufacturers and industrialists. And many educators are officers and committeemen in the national and local engineering societies. Indeed, those teachers who do maintain close contact with industry may rise in indignation and protest that relations between colleges and industry are in a flourishing condition.

But I suspect that the active researchers, consulting engineers, officers and committeemen in the societies are not typical of the faculties. If we check over our faculties man by man, shall we not discover that the most of them circulate in the narrow orbit of home, office, classroom and laboratory, and have not been near a manufacturing plant or a construction job for a year or two; or possibly six or seven? Are there not many among our faculties who tend to forget that engineering is a practice, a profession, and who tend to drift into the purely academic phases of their work? Are there not at least some, especially among our promising young intellectuals, who begin to look upon jobs in plants as just a little vulgar?

Majority into Private Industry

One might raise the question: Why bother; why not let the professors and the industrialists go their separate ways? The answer, or answers, constitute the reason for this year's special Society keynote.

Research has been the glamor field of work for the best of the engineering graduates in recent years. A rapidly increasing proportion of the engineering bachelors have gone on to the graduate schools. And more and more young engi-

* Presented before the Engineering College Administrative Council of the ASEE, Washington, November 18, 1948.

neers have become interested in various government and municipal jobs. But in spite of these fascinating occupations, the fact remains that the vast majority of our engineering graduates carry their diplomas away from the commencement exercises, do or don't enjoy a short or long vacation, and then hang up their hats in some industrial plant, office, or drawing room and go to work. Seventy-eight per cent of American engineers, four out of every five, are employed in private industry, according to "The Engineering Profession in Transition," published last year by the Engineers Joint Council.

Enlarged Opportunities

There is another reason for this year's choice of a special project.

The Manpower Committee of the Society has declared its opinion that our industries, without straining, can absorb the sudden swarm of veteran graduates in the next three years. But the industries face an enormous task. The seniors of any year are approximately the graduates of that year. The number of senior students in American and Canadian colleges and schools of engineering has been growing rapidly, as follows:

Year	Senior Enrollment
1926	9,000
1936	10,300
1942	17,100
1948	32,400
1949	45,700
1950	51,000 (probable)

Notice that the interval between years in the tabulation is not equal, and that the curve, if one were plotted, would indicate a sharp acceleration. There is a parallel acceleration in the difficulty of finding jobs for graduates, regardless of our conviction that the jobs can be found.

The Manpower Committee, I believe, has based its studies upon a very small number of corporations which have always hired engineering graduates as a matter of long-standing policy.

It is perfectly clear to the Committee, and to any of us who look into the matter, that a distinct, possibly an infinitesimal minority of American engineering employees have taken on the great majority of the boys who come out of the colleges.

And it is perfectly clear, likewise, that there are countless opportunities for graduates in thousands of large and small plants, along thousands of railroad sidings from the Atlantic to the Pacific.

The officers of the Society are of the opinion that the first step in the process of breaking out these opportunities is for the industrialists and the professors to get acquainted with each other. After that is accomplished the rest ought to be *comparatively* easy.

New Functions

There is another reason for this year's special objective.

The Society's Committee on Relations with Industry held an excellent session—several excellent sessions—at Austin last June. In the session to which I refer, competent and informed speakers pointed out abundant opportunities for engineering graduates in functional fields which graduates have heretofore almost completely ignored. Graduates and college placement officers have concentrated almost exclusively upon familiar jobs in design, experiment and test, sales, research and the like. They have largely overlooked jobs in plant engineering and maintenance, production and manufacturing, and the operation of engineering facilities of whatever kind.

I suggest that we check over our alumni lists when we return home. How many graduates can we find in such positions? And then let us drive in and around the important manufacturing plants in our respective neighborhoods. Let's size up the vast buildings, the complicated installations of machinery and equipment, and the auxiliary facilities for power, heating and ventilating, lighting, water supply, sanitation, transporta-

tion. Let's visualize how many engineers might be engaged in caring for all these equipments and facilities. And I mean professional engineers, apart from very many graduates of technical institutes.

The works manager has an excellent position in any except the smallest establishments. We used to call him general superintendent. How many young engineers can any of us name who are pointing for such a job? The plant engineer has charge of machinery and equipment, and of the layout and preliminary design of new plants and extensions. We used to call him master mechanic. How many young engineers do we know who are reaching for such responsibility?

In former years, these jobs were filled by expert craftsmen with a gift for leadership, mostly immigrants from Europe. But that generation of stalwarts has nearly passed, and nobody has replaced them. There exists an immense vacuum, so to speak, ready to absorb thousands of young engineers.

Besides, plant administration has become so complex, and involves so many intricate technical problems and decisions, that mere skill with tools is no longer adequate, and complete engineering training is required.

One important American manufacturer of heavy machinery, largest of his kind in the world, will no longer groom anybody except an engineering college graduate for a plant administrative job. And Mr. George Dreher, the executive of the Foundry Educational Foundation, declared on Thursday that his industry hopes to induct twenty thousand engineering college graduates as soon as they can be found.

Engineering teachers will just have to get out among the industrialists, find out about these openings in the plants, and tell their students about them. And possibly one or the other of the teachers will have to learn, somehow or other, to be just as proud of his graduate who is a distinguished plant manager as of another graduate who is an outstanding chief engineer.

Small Industries

Again, in 1946 at St. Louis, the Committee on Relations with Industry devoted a highly successful session to engineering opportunities in the small industries. And Professor Robertson tells us that conferences on the subject have been held at the University of Minnesota.

There appears to be an enormous and undeveloped outlet for engineers in tens of thousands of small plants and establishments. The small employer hires a young engineer, when and if he hires him, for immediate production starting at eight thirty tomorrow morning, not for what he can make of him ten years hence: He hires a work horse, not a long term investment. When a draftsman quits at noon on Saturday, the small employer frantically telephones the nearest college early on Monday morning. Practically no small industries have set up policies for systematic and continuous development of technical men.

All this is natural enough. The typical small employer is doubtless a smart and enterprising workman who has mastered the know-how of some tool or process, has raised a few hundred thousand dollars and has set up a little business. Frequently this little business is auxiliary to a principal industry of the locality. In our Detroit territory the small industry is likely to be a heat treatment plant, a tool or die shop, a foundry, or a die casting, welding, chemical processing or instrument making plant.

Let me cite an example to show the degree to which young engineers stay out of small plants. Detroit is one city about which I may speak with some show of authority. The Engineering Society of Detroit has about five hundred junior members. The Society made a study of these junior members two years ago, and two hundred and forty-nine of the juniors, almost exactly half, returned the questionnaire. Of these two hundred and forty-nine, twenty-four were employed in small industries. That means

a total of forty-eight, if we may assume the same proportion among those who failed to return the questionnaire.

Now, the Detroit Board of Commerce reports that there are about 3,300 manufacturing establishments in Detroit and the suburbs. Presumably at least 3,000 of these are small.

Forty-eight young engineers in 3,000 industries!

Of course, not all young engineers in Detroit belong to the Society, but we contend that the best of them do.

It is unlikely that the small employer will become interested in college graduates unless he knows an engineering college professor and thinks he is a pretty good sort of person. And the small employer will not know any college professor unless the college professor cultivates his acquaintance.

Status of the Professional Engineer

There is still another reason why industrialists and educators should know each other better, and that is the uncertain, confused and misunderstood status of the professional engineer who is employed, as compared with the consulting engineer. As a rule, the distinction between professional engineers on the one hand, and draftsmen, technicians and even artisans on the other, is not clearly understood by employers; nor, indeed, by engineers themselves.

Read the code of ethics of the Engineers' Council for Professional Engineers, or of any one of the national engineering societies. You will soon detect an undertone. The codes are quite appropriate for all engineers, of course, but they were obviously written very largely from the viewpoint of the consulting engineer. Nevertheless, the Engineers Joint Council lists only 3.6 per cent of all engineers as consultants.

Employed engineers, especially young engineers, are so restricted in their jobs by the policies and regulations of their employers that they have but little opportunity to develop a professional consciousness. And the advertising and internal morale building of the typical American corporation are so potent that after twenty years of experience in such a corporation, the engineer has almost forgotten that he is a member of an important profession, but is highly conscious and proud of his status as a Chrysler man, a Standard Oil man or a Bethlehem Steel man. There are exceptions among the electrical equipment manufacturers and the utilities, and possibly elsewhere.

Very many problems cluster about the professional status of engineers employed in the industries. Engineering educators may be able to help solve at least some of those problems, but they will first have to get better acquainted with the engineers in plant positions.

Conclusion

I have spoken mostly about manufacturing industries because I happen to be a mechanical engineer, and more familiar with such industries. But I suspect that conditions are much the same in construction, and in other fields of civil engineering, and in most of the other branches of the profession.

The officers of the Society propose to make "Partnership with Industry" the special topic for the annual meeting at the Rensselaer Polytechnic Institute next June, and the keynote for the year's work in the Society. Vice-Presidents Robertson and Saville have already set machinery in motion to feature relations with industry in the sessions and projects of the Sections and Branches and of the Committees and Divisions, both in the annual meeting and in the course of the year. I am sure that Vice-Presidents Steinberg and Dawson likewise have appropriate and challenging programs in mind for the Engineering College Administrative and Research Councils, respectively.

The Committee on Relations with Industry will stage an important gathering

of industrialists and engineering educators next June. They have begun work, their hopes and plans are exceedingly ambitious, and this gathering, which has been called a "circus" in order to suggest the scope of the undertaking, should mark an important turning point in the relations between the educators, and the engineers in the plants and in practice.

I have tried to explain why the officers selected the special objective for the year in the Society; I hope that the explanation has been convincing. And I plead with each one of you to promote "Partnership with Industry" to the best of your ability within your respective spheres of influence, and in so far as doing so may be consistent with your positions and the tasks to which you are committed.

College Notes

A two million pound-inch torsion testing machine believed to be the world's largest and accommodating specimens four feet and four inches in diameter and sixteen feet long has been proof tested at the Fritz Engineering Laboratory of the Civil Engineering Department of **Lehigh University.**

Designed to study the torsional behavior of structural members such as plate and box girders, the testing machine is capable of handling full-sized bridge sections, twisting them through any desired angle. The machine itself is approximately nine feet high and 25 feet long with a gross weight of 15 tons and a center line 46 inches above floor-level.

A program of graduate work in Engineering, Physics, and Chemistry—leading to the master's degree—is to be inaugurated at **Drexel Institute of Technology** beginning with the Fall term according to an announcement by President James Creese.

Robert C. Disque, Dean of the College of Engineering, said that seven curricula will be offered in the new program, leading to a degree of Master of Science. They are Aeronautical Engineering, Civil Engineering, Chemical Engineering, Electrical Engineering, Mechanical Engineering, Chemistry, and Physics.

As in each of the triennial meetings held by the **Iowa Institute of Hydraulic Research,** the technical sessions of the Fourth Hydraulics Conference, scheduled for June 12–15, will reflect a particular and timely theme. One of the greatest needs of the profession today is a comprehensive and authoritative presentation of hydraulics as a broad engineering science. The Institute has therefore invited leaders in the major subdivisions of the science to prepare papers which will form the consecutive chapters of a book on "Engineering Hydraulics." These chapters have been carefully correlated by the Institute staff, and are now being preprinted by photo-offset from galley proof for thorough discussion at the conference prior to final revision and publication. Those participating in this endeavor are:

Hunter Rouse,
J. E. Warnock,
J. W. Howe,
G. R. Williams,
C. E. Jacob,
V. L. Streeter,
J. S. McNown,
A. T. Ippen,
C. J. Posey,
B. R. Gilcrest,
G. H. Keulegan,
C. B. Brown, and
J. W. Daily.

The Problem Method in Humanistic Studies*

By C. HAROLD GRAY

Head, English Department, Rensselaer Polytechnic Institute

Engineering students are habituated, through the disciplines of mathematics, science, and technology, to ask, "What is the problem?" They are not accustomed to the kind of indefinite absorption of knowledge which too often characterizes humanistic subjects. Unless they understand that also in these subjects are problems that demand solutions, they will not participate actively in a genuine experience of learning. If we overlook their characteristic problem-solving attitude, our own activities will seem to them vague and purposeless.

I therefore deliberately challenge the notion, common among English departments in universities where engineering students attend the same courses as the liberal arts students, that engineering students are not different from other young people and that the teaching of literature, writing, history or philosophy need not be conducted differently for them. While we may assume that as human beings they are not innately different from other people, we should not conclude that their previous experiences, their professional ambitions, and their highly developed skills in certain studies will not make the problem of teaching them different from that of teaching students who have been differently conditioned. Because they have doubtless fallen in love, once or more than once, we need not conclude that at ten o'clock on Mondays, Wednesdays, and Fridays we can throw love lyrics at them between a class in mechanics at nine and a class in photogrammetry at eleven, without giving some thought to how their minds are working at ten o'clock and what we are trying to do with those lyrics. Our first obligation, as well as our first step towards success in our teaching, will be to understand as much as we can about the intellectual habits of our students and to use that understanding as a basis for the selection of humanistic studies and the methods by which we shall teach.

Characteristics of Engineering Students

Engineering students, then, differ from other students I have known in having a more habitual desire to know right off the bat what the problem is or what real question we are asking. If we seem to be demanding in our humanistic or social studies that surveys of factual material or reproductions of text-book discussions be memorized and returned to us, they will know exactly how to go to work. From such courses, however, they will not derive the benefit which humanistic studies are supposed to provide. I assume that the purpose of such studies is to lead the students to think more critically about problems of human life. They are already dealing with some of these problems in their scientific and technological studies. They are mastering the modes of thought, the principles, and the methods by which solutions are arrived at. Being aware of the importance of the engineering problems, they are wholeheartedly involved in an effective learning process.

To get the same degree of involvement

* Presented before the English Division Conference at the Annual Meeting, Austin, Texas, June 17, 1948.

in the study of humanistic and social subjects, we need to keep more obviously to the front what problems we are up against and what modes of thought, principles, and methods we use to solve them. This is a very different process from memorizing other people's solutions or answers. Although the knowledge of other answers is of course useful in the formation of new judgments, we need to take as our first objective the statement of a problem, the establishment of its importance, and the stimulation to active thinking about solutions. If we do not we shall leave our students with second-hand information or with only faint traces of somebody else's thoughts. We cannot call that "culture"; it will be nothing but inert knowledge. "We learn what we accept to act upon," says one of the wisest of American educators, William Heard Kilpatrick. In science and technology the learning of our students is real because what they learn there they do "accept to act upon" in all their future study and living. Somehow we have to get the same kind of result in our humanistic teaching or the time given to us will be a waste of students' time.

Problems or Accumulation of Knowledge?

I have been assuming that the words "problem" and "solution," familiar words in mathematics or science and engineering, are equally familiar in humanistic studies. We have been, however, perhaps too much inclined to think of these studies as the accumulation of knowledge *about* the history of the United States, *about* the development of the large corporation, *about* Aristotle or Socrates or Shakespeare, or *about* the epic and Freudian psychology. As students of such matters, we presumably feel that the study of them does something for us as men alive in our times, and we presumably know what it is that we are doing as we study. A teacher of engineering studies certainly has no difficulty in making clear to his students what can be done with his knowledge and what he does when he is getting that knowledge. In the teaching of humanistic and social studies we have not often enough given our students the sense that each of the humanistic disciplines is directed towards the answering of questions or the solution of problems. We have talked too much about "background," "culture," "the higher things," and the "enjoyment of leisure hours"—or about "what an educated man should know." We forget that the young technological Shylocks are sitting before us asking, "On what compulsion must I?" I should like to see us translate that phrase about "what an educated man should know" into a more dynamic phrase for general education: "what an educated man does when he tries to solve human problems."

Now, what are some of these problems? How would the direct attack upon them constitute a curriculum and method for humanistic-social studies? My examples in this brief exposition will be chosen for their dramatic value. They are not proposed as a course, nor as necessarily the first problems to attack.

One of the dominant problems in our country at the moment is that of militarism. The discussions of universal military training and of the peace-time draft demand critical thinking from all of us. Our students are vitally involved in them. Who knows what data are necessary and useful in the effort to come to a conclusion? What constitutes valid reasoning from history? Can history tell us whether standing armies have prevented war or have promoted war? Has anything been found out about the effect of military training upon the minds and wills of young men? How has such knowledge been arrived at or how could it be arrived at? What questions of the relation of the individual to the state does this question of Universal Military Training raise? How does one arrive at conclusions in such matters, conclusions with anything approaching the validity of conclusions in science and technology?

Humanistic education, rightly conceived and practised, would attack such a prob-

lem directly. We would begin with a problem which no student can dodge or would want to dodge; all of them would be involved. We use the facts of history and the principles of historical reasoning, and we above all show them how to get such facts and how to use such reasoning. We should also be put on the spot for whatever conclusions we may have drawn ourselves; our students would soon have the tools for criticism of any class-room dogmatism or propaganda.

Since for most human problems the state of knowledge is not yet adequate for final conclusions, students too often get the impression that one man's opinion is as good as another's. That kind of relativism in all matters apart from science is another characteristic of engineering students. The method I am suggesting would replace such relativism with a greater respect for the conclusions of any good thinker and even with a healthy respect for differences *between* good thinkers. While I am stressing, however, the acquisition of a method of thinking, it will be obvious that the student would get this only insofar as he has accumulated in the process a reasonable amount of data. The "background" will have grown, but by reason of its use in problem-solving it becomes that much more valuable, life-giving thing—"foreground" knowledge.

Another dominant question in the minds of us all, at whatever age, is what we shall do about our sexual morality. That the Kinsey Report has become a national best-seller at six dollars and a half is only a bit of unnecessary proof of our fascination. Sex has always been a problem—individual and social—but in our scientific age it has taken on a new ominousness.

Now what humanistic education could be derived from a direct attack on this problem? Whom do we go to for our data on this problem? To the family doctor? To Dr. Kinsey and his associates? To Havelock Ellis? To the priest and the latest encyclical from Rome? To St. Augustine and to Sigmund Freud? To the Bible and Shakespeare and James Joyce? Once we have the physiological data, are the moral and religious problems solved? Or once we have the church's command, are the physiological and psychological problems solved? How can we isolate the factors in the total problem? What are the bases of valid thinking about these factors, by themselves and once again put together? Believe me, unless we tackle such problems with such questions in mind, we shall leave our students untouched in their most vital spot. Indeed, if we instead lay out a course of reading in Aristophanes, Chaucer, Rabelais, Shakespeare, Byron, and Shelley, we may leave worse confusion than we found. With such a single problem in our minds, the history of literature and of human morals will come alive. And once it is alive, it will yield innumerable by-products, especially innumerable other problems, nearly if not quite as interesting. The emphasis again must be, not upon the mere relativistic anarchy of human experience, but upon the fundamental disciplines by which scientific order (or something as near to science as we can get) can be brought into knowing, thinking, and feeling about human experience.

For my third problem I choose the most dramatic of all: What is the meaning of "good"? That same relativism which I have referred to before as a disturbing characteristic of students is nowhere more dangerous than in the sphere of ethics. "What I think is good," they almost always say, "may not be good for somebody else; it's just my opinion." It is at least open to question whether the relegation of moral values to "any man's guess" may not mean the end of a civilization. In our zeal to "cover" the history of Western Civilization or the history of English Literature or the principles of "general psychology," we may again be missing our sole opportunity to challenge this ethical anarchism.

The question, What is good? lies active and even burning behind the brows of

these young engineers and all young people. Shall we go on side-stepping it? Every day they develop better and better standards of workmanship and accomplishment in their technical fields. They know where to go for guidance. In their judgments of human behavior they find little guidance, and they show a surprising immaturity. I know that there are other agencies than the colleges which need to bear this burden. We could not, however, spend the hours allotted to the "humanistic-social stem" in any more fruitful manner than in attempting some honest examination of the ethical problem. Our philosophical, historical and literary texts could be chosen with this problem in mind.

Again I stress the point that the aim of the method would be to open up sources of data, modes of thinking and principles on which judgments can be based. If we were to replace the dogmas of immature prejudice by dogmas of our own—perhaps overripe—prejudice, we should not do the humanizing job. We need to tackle the problem of thinking in the field of human values. Do we turn from the scientific method to a purely authoritarian method? If so, what justification can be given for that divergence? Do we permit or foster, in the study of values, the reliance upon emotion, which in scientific study we try to keep out? If so, what justification can be given for the cultivation of emotion? Can we find out what is good in human action by the experimental or empirical method? On what basis do we arrive at and test or justify the judgments we make every day? In what ways do the best thinkers of the past and present help us to know what "good" means? How shall we find our way round among conflicting points of view?

Just as in the questions of militarism and sexual ideals, we shall find that our students are already asking themselves such questions about good and evil. They are bold enough occasionally to ask them of us—outside of class. The things we consider irrelevant or extraneous to the substance of our courses are too often the only things our students "accept to act upon." That tragic gap is caused by our failure to take as the central business of our classes the vital problems of life on which our knowledge has, could have, and should have some light to shed. Critical thinking is not a mere accidental by-product of scientific and engineering education; it is the very life of the process. It should be the deliberate aim of humanistic education as well.

I have now touched on three problems only. The number of such problems is infinite. Selection must be made, it seems to me, by each teacher or by each group in charge of any one of our humanistic courses. From decisions on the problems will follow the selection of readings. The problem method, as I have called it, gives principles of selection other than such principles as personal tastes, the ease with which students can read the books, patriotism, regionalism, literary piety, or the fear to "leave out Shakespeare or Homer."

We cannot do just a small piece of the same kind of teaching we devote to liberal arts students. I believe we have to see our problem as a different one, and to make capital out of the differences. With a clearer sense of what we are doing will come to our students greater respect and more whole-hearted cooperation. I even think we can lead the way in the search for a "general education" program suitable for all kinds of institutions. For what I have been suggesting is based on a sound educational psychology. The most effective education given in this country at present is that in scientific and technical institutions just because it is based on that same psychology. We in the humanities might do well to take a leaf out of the engineers' book and ask ourselves afresh, "What is the problem?"

How to Recognize and Reward Good Instructors*

By H. P. HAMMOND

Dean of Engineering, Pennsylvania State College

This is a very perplexing topic. It is hard to pin it down to definite, objective analysis. If I were like the football player who replied to a question on a condition examination he was taking in order to be eligible to play, I would be tempted to say, as he did, "I don't know," and hope to get a passing grade. The most I can hope to do is to give a few observations in the hope of bringing out ideas of others, for the subject is an important one.

I can not hope to say how a totally inexperienced young man can be identified as a promising candidate for a teaching position except by the familiar criteria of a good scholastic record, evidence of good character, a pleasant and apparently sufficiently strong personality, education and/or experience beyond the undergraduate level, and a clear desire to teach. These are too obvious and well understood to need discussion. So I shall confine my consideration of the subject to some discussion of how the department head or dean may spot a promising young teacher after there has been some opportunity to observe him in action; that is, during his first two or three years as an assistant or instructor. This is the period in which the young teacher develops the traits and displays the qualities that he is likely to carry with him—though more strongly developed—throughout his teaching career. He then possesses also, of course, the inherent traits of character and ability he had still earlier, though they may not have been discernible, in relation to teaching, at an earlier time.

* A talk delivered at the annual meeting of the Allegheny Section for the American Society of Engineering Education, October 15, 1948.

Desirable Qualities—Ability to Get Along With People

Here, then, are some of the qualities I should look for and which I ought to try, as an administrator, to find in a young teacher, or perhaps I should say, to create the occasions for observing:

First, the ability to get along with other people, including especially the students with whom he comes in contact. This requires, at the foundation, I think, the characteristic of liking people, and especially of liking students. This applies both to liking them as individuals and as class groups. The kind of young men I am thinking of, and there are a good many of them, really like to have students come to them for help, and would recognize, if they stopped to analyze it, that they step into his classroom to meet their classes with a pleasant and alert feeling of anticipation. This characteristic, I think, is a *sine qua non* of the good classroom instructor. Without it, a man might be a gifted lecturer, but he would not be the kind of teacher on whom the bulk of the good classroom instruction depends. How can a department head or dean identify the instructors who possess this quality and learn to how great or less degree they possess it? This is one of the intangibles of administraton which it is hard to define. It rests in part, I think, on the feeling of confidence and good will the administrator in turn holds in respect to his staff. Given an interest in his individual staff members and the desire to know about them, I think most administrators would testify that they come rather quickly to learn about these human qualities in their younger teachers.

Ability to Inspire Student Participation

Second, I believe that a good teacher can be identified by the extent to which he succeeds in "drawing out" his students—inducing them to do things for themselves instead of continually doing things for them. This is a quality not possessed so often as are the characteristics of friendliness and cooperativeness already referred to. Yet it is one of the most important characteristics a highly successful teacher can possess. And evidence of it should be exhibited early. Of course, the development of this quality is as much the duty of the administration of the school or department as it is of the instructor himself. Often, unless the development of a method of instruction which requires the student to do the work instead of having it laid before him, is made a definite policy of the school or department, it will not be done. Its accomplishment is a mutual obligation on the part of teacher and administrator.

I should like to digress to discuss this point a little further. Of all the serious faults of engineering education, one of the most important and at the same time most widely prevalent is the method that has been called "reciting the lesson for the student in the classroom"; that is, of assigning for home preparation a section of the textbook and then of going over it in the classroom with meticulous care to see that everyone understands it, but, in this process making little or no attempt to have the students do anything for themselves. I once heard Professor Warren K. Lewis, the Lamme Medalist of last year, say, in response to a question as to the secret of his ability as a teacher, that it was to get the student into a corner, figuratively speaking, and force him either to get himself out of it or to admit defeat and come back another day prepared to do so. This exemplifies what I mean by making the student do the work instead of doing it for him. I have heard it said that if a stop watch were held in the average classroom in which a *recitation* was supposed to be in progress, the teacher would be found to do the talking 90 per cent of the time. I believe, from my own observation, that in a great many instances this statement is not an exaggeration.

And the same general situation prevails in a great many of our laboratories. We call the work done there *experiments*, but most of it is not true experimentation at all. It is the performing of *exercises*, carefully laid out in detailed instructions to the students, specified lists of equipment, and ruled sheets sometimes even supplied with column headings, in which to enter data. Of all the undergraduate programs of education, engineering is perhaps the richest in providing possibilities, through a balance of our three types of instruction—recitation, laboratory, and design—of giving students a sense of the reality of what they study and of developing their resourcefulness and originality. I do not say that we fail completely in the realization of these aims, but I fear that we do not do our best to accomplish them. I believe there are two deeply fundamental reasons why we do not do so: first, we lay out so much for the student to do that there is simply not enough time to develop any part of it in such manner as to realize its full educational potentialities. Second, we just do not ourselves put the energy, resourcefulness, originality, and thought into our teaching that is needed to develop those traits in our students. It may be felt that what I am here preaching is a counsel of perfection. I do not think it is. The first step, and I say this with the greatest force I can command, in the direction of attaining these objectives is simply this: reduce our curriculum load on the student and the teaching load on the faculty by about 20 per cent. That does not mean to require anyone, student or teacher, to do less work. Quite the contrary. But it does mean laying out a reduced amount of ground to be covered so that it can be covered more thoroughly, so that grasp of fundamentals may be insisted upon, so that the student is forced to do things for himself instead of hearing about them or

witnessing them done for him, so that he may have a chance to blunder a bit in the laboratory and thereby learn for himself instead of meticulously following closely prescribed instructions, and so that he may, as occasions present themselves or may be created for him, have an opportunity in some measure to develop his resourcefulness and originality.

Now to return from this digression, and to restate the point I was discussing, I believe the second fundamental quality to look for in the young instructor whom we hope will become a faculty leader is evidence of ability to bring the student out instead of habitually talking down to him.

Personal Development

Third, of course, we should look for evidence of the drive for further personal development. This trait can be identified fairly readily, for it exhibits itself in quite evident manner: the pursuit of graduate courses beyond specified advanced degree requirements; originating a bit of research, even if small or rudimentary; making suggestions about course improvements; identification with professional societies; conferring frequently with students outside of class; and so on.

Lacking evidences of such characteristics as those just mentioned, I think it can be predicted with some confidence that an instructor is likely to become the rut-seeking type; and his contract with the college should be limited to a very short term.

These, then, I think are the three chief classes of characteristics by which the administrator may hope to recognize promising young instructors: a liking for students and the ability to get along with them and to command their respect; the desire, and the knack, of getting students to do things and to discover things for themselves; and the ambition, backed by inherent capacity, to get ahead through development of knowledge, ability, and interest. All of these must, of course, be based on good character, health, and mental capacity. When this combination is identified it need scarcely be said that a potential faculty leader has been discovered.

How to Retain Good Instructors

The problem then is to keep such a man. And it is then that the administrator's worries really begin.

It need scarcely be said that the paying of an adequate salary is indispensable if good men are to be secured and retained. And the salary must be increased steadily as the man's value to the institution and his own personal responsibilities increase. We all know—it has been forced upon our attention—that an educational institution can not, with rare exceptions, equal salary scales that prevail in industry or, now, even in government. Therefore, a man who has the capacity to make himself useful in industry as a practicing engineer, or in government as a researcher, can not look for the same salary in an educational institution which outside opportunities might offer him. It is also our experience that in a good many instances it is not necessary to offer equal monetary reward in an institution to that which may be available elsewhere. There are real compensations which exist in educational work outside of financial reward. But reliance on the favorable conditions pertaining to teaching careers cannot be relied upon, as they often are, to the extent of forcing a valuable teacher to work at such a low salary that he can scarcely make both ends meet or bring up his family as he ought to be able to do. This deplorable condition is far too prevalent throughout higher education in the United States today. In a word, then, a reasonably adequate salary and a reasonably assured financial future is indispensable to the retention of able and promising young faculty personnel.

The retention of good teachers, however, does not rest on salary alone, even if adequate salaries can be paid What the ambitious young man also needs is the provision of facilities such that he can do his work under favorable circumstances, and such that he can promote his own

development by originating technical or educational developments. It is only human also for a young man who is doing well to look for commendation and encouragement from older colleagues or administrators. I think we are inclined to overlook or underestimate how much a young teacher will value a word of appreciation or commendation now and then. An able young teacher will also, and this I emphasize, expect competent leadership and some degree of guidance both from his department head and, perhaps somewhat less directly, from the administrator of his school. An able young man will want to do his work in an environment and atmosphere conducive to his personal development and in an institution which is on the upgrade—one in which he sees around him evidences of progressive policies looking to the betterment of the institution all along the line. This, of course, goes back to the fundamental characteristics of the entire institution, including strong and competent leadership by its President and Board of Trustees, as well as to the head of its engineering unit.

The title of this talk included the phrase ". . . Reward Good Instructors." It seems to me that in a broad sense the rewarding of an instructor, outside of financial returns and personal recognition, rests in the provision of conditions under which the young man may, in a sense, work toward the accomplishment of his own reward; that is, under conditions conducive to his own self-development.

While I do not wish to attempt in detail to appraise conditions in higher education throughout the country in respect to these evidences of progress, I do wish to say that in general among the stronger engineering colleges the conditions that I have just enumerated as requisite to the retention of able young teachers do, in fact, exist in considerable measure. Engineering education, on the whole, is both strong and vigorous in our leading institutions. Except for the one great handicap of financial limitations, and, to a considerable extent, in spite even of this, engineering education is in essentially sound condition. I believe the inherent condition exist under which we can attract, retain, and develop strong engineering faculties.

College Notes

Mr. Kenneth F. Tupper, Director of the Engineering Division of the Chalk River Atomic Energy Project of the National Research Council of Canada, has been appointed Associate Dean of the Faculty of Applied Science and Engineering of the **University of Toronto.** He will succeed Dean C. R. Young on July 1, 1949.

The appointment of Dr. Julius A. Stratton, Professor of Physics and Director of the Research Laboratory of Electronics, as Provost of the **Massachusetts Institute of Technology,** was announced by Dr. James R. Killian, Jr., President of the Institute.

The academic post of provost is a new one at M.I.T., and Dr. Stratton, whose appointment becomes effective on April 15, will share with the president and the deans the administrative direction of the Institute's educational program.

Engineering Education in Great Britain

By CHARLES SUSSKIND

Graduate Division, School of Engineering, Yale University

A recurrent theme of the report published recently by the President's Commission on Higher Education [1] is the recommendation that education on the professional level should be made available to a greater number of students. Such a policy, as applied to engineering education in America, has been subjected to criticism ever since the engineering college ceased to be a "school of the industrial vocations" and adopted the collegiate plan of organization. It may be of interest to examine the merits and shortcomings of a system of engineering education apparently based on exactly the opposite policy: the British system.

To realize the vast difference between American and British university attendance figures, it should be borne in mind that in 1947 there were only 2000 full-time engineering students registered in all the universities of England and Wales; [2] the figure for Scotland, though somewhat higher in proportion to population, was of the same order of magnitude. The American educator may well ask how a highly industrialized country, with a population one-third that of the United States, can get along with an engineering-college population roughly one-hundredth that of the U. S.? The answer is that British universities supply only a small fraction of the technological personnel needed by industry. The bulk is trained by technical "colleges", in part-time and evening classes, and through correspondence courses.

Technical Institutions

The technical colleges afford a wide variety of courses for the industrial vocations, as well as for the trades. They differ from the universities mainly in that they do not confer degrees; their entrance requirements are consequently somewhat lower and they can accommodate many students who, from economic considerations or otherwise, could not remain in secondary schools long enough to reach the matriculation standard. Part-time and evening attendance (not feasible at the universities), as well as the lower tuition costs, combine to provide educational opportunities for many young men who would otherwise leave school for good at 15 or 16. The attainment level of some of these institutions compares favorably with that of many American universities. In some cities the technical schools are tied more or less informally to the local universities, and the exceptional student is often encouraged to proceed toward a degree. For instance, some of the excellent Polytechnic Institutes managed by the London County Council have university-approved teachers, and students may take the "internal" Bachelor's degree of the University of London; whereas in Scotland, most of the courses given by the technical colleges may be credited toward a university degree. For other students there is a complex system of "leaving certificates" to show the work done; among others, the so-called National Certificates in the various branches

[1] *Higher Education for American Democracy*, Report of the President's Commission on Higher Education. New York: Harper & Bros., 1948. 431 pp.

[2] *Education in 1947*. Report of the Ministry of Education. London: H. M. Stationery Office, 1948. 201 pp.

of engineering and the Diplomas for examinations administered by the City and Guilds of London Institute, are widely recognized by employers.

Another standard of attainment is membership in one or more of the professional societies. A measure of the rôle played by such bodies in British life is the fact that most students of law, medicine, and other well-established professions qualify (*i.e.,* earn the right to practice) by passing the examinations of their respective professional societies, without ever having attended a university at all! This system, an outgrowth of the old pupilage scheme, has quite naturally extended to the younger engineering profession. The various grades of membership—Associate, Associate Member, Member, Fellow—can be attained only after rigorous examinations which are often quite on a par with university standards; this fact accounts for the usual profusion of abbreviations and initials signifying the various memberships whenever the name of a British engineer or scientist appears in print.

Universities

British universities may be divided into four groups, each group catering to approximately the same number of students. The ancient Universities of Oxford and Cambridge form one group; London University, with its many colleges and affiliated institutions, the second; the eight more recently founded civic universities located in the large cities of England are the third group; and the fourth comprises the four Scottish universities, as well as one each in Wales and Northern Ireland. With one exception, each university has a faculty of Engineering, mostly quite small, averaging less than 200 students. The usual residence requirement for the ordinary B.Sc.(Eng.) degree is three years; this period is comparable to the customary four-year requirement in America if it is remembered that virtually all humanistic studies are excluded from the British curriculum on the principle that they should have been concluded in secondary school. The Honours degree, which requires a more extensive or, at some universities, a more extended period of study, has a much higher standing than the ordinary degree; unlike his American counterpart, the British "honours" student is from the outset placed in a separate category and arranges his plan of study accordingly. The Honours degree is almost invariably the prerequisite for more advanced degrees, which are awarded mostly on the basis of research, theses, and practical experience; graduate study in our sense of the word, with students attending classes, is quite rare.

Instruction in British universities bears a marked intellectual emphasis. There is little reliance on textbooks; instead, the student is expected to do a good deal of outside reading on his own. Examinations are usually comprehensive, rather than detailed, in character; the students are expected to obtain practical experience by working in factories during vacations or, at some universities, through the sandwich (cooperative) plan of alternating study with industrial apprenticeship.

As can be expected, British universities are highly selective. Efforts are constantly being made, especially through increased scholarships (the number of which has been trebled since 1939), to ensure that the selection is determined by scholastic standards alone, rather than by the student's means. It is the proud claim of British educators that no student, if he only has the ability, need be prevented from attending a university by pecuniary reasons. Nevertheless many families cannot spare the son's earnings for the long period of study, and a tendency toward social stratification persists. It remains to be seen whether the system of grants for veterans, introduced as a result of a postwar scheme somewhat akin to the G.I. Bill of Rights, will be extended in scope. If such a plan is adopted, British university education will be rid of the main disadvantage from which it suffers in comparison with the American system: limited availability. For various reasons—academic, social, and

economic—it has never been feasible for the British student to "work his way through college"; a greater accessibility of higher education could probably be achieved only by means of cash subsistence grants to needy students.

The British Example

Even if the British university is gradually made available to a wider section of the population, it is doubtful whether the over-all enrollment will be increased. A survey [8] made for the Ministry of Education in 1945 speaks of *maintaining* the wartime attendance figures, but not of increasing them. British industry and government are well satisfied with the dual system of engineering education. They are content to allow the universities to continue in their leisurely, unhurried task of producing the type of man who will find his place in research, education, government, and the planning side of industry; technicians for the operating side of industry are more profitably prepared at the technical institutions having curricula which are readily adaptable to industry's local needs, and generally show a decidedly more practical (*i.e.*, vocational) approach to engineering. The universities, for their part, remain free from the necessity of mass production and can devote themselves more fully to intellectual, scholarly pursuits.

Other aspects of the British system of interest to American educators and engineers are: (1) abundant provision for the education of sub-professional personnel, both for industry and the trades; (2) the far-reaching influence of engineering societies on curricula by means of the nationwide standards imposed by membership examinations; and (3) formal recognition of nongraduate attainment by various credentials.

The latter item should be of particular interest to us: many observers fear that the value of the American university degree threatens to become inflated to the point of being rendered meaningless. The granting of diplomas of "Associate" at the conclusion of a two-year terminal program, as practiced at the University of Nebraska, is a step in the right direction; so is the Junior College plan adopted in California. We should realize that the many undergraduates who leave our universities after one or two years, at an educational level which is neither useful nor recognized, represent a terrible waste of effort—both for the individual and for the school; not until some definite provision for the education and formal recognition of engineering technicians is made will this waste be avoided.

[8] *Higher Technological Education.* Report of a Special Committee. London: H. M. Stationery Office, 1945. 32 pp.

Teaching Engineering Economy

By EDMUND D. AYRES

Professor of Electrical Engineering, Ohio State University

Seventeen years of teaching engineering economy to electrical, mechanical, chemical, civil, mining, and metallurgical engineering students has produced for the writer what he believes to be an effective approach to the problem. Certain features of the approach such as the conditioning survey, the D-level examination, and the problem section method of grading are believed to deviate from the usual teaching methods sufficiently to warrant some description and some statement of the teaching philosophy justifying their

Problem Section Method of Grading

Engineering, physics, and mathematics are all taught with liberal use of quantitative application. A course in any of these subjects should bring a challenge to the student—a challenge to his ability to apply basic natural laws to the solution of problems—it is hoped a challenge which will develop the thinking process. In a similar manner a challenge to the student to think through an engineering economy problem reacts upon him favorably. He gains a respect for the subject which is analogous to his respect for the scientific subjects. Grading him on his performance in problem sections emphasizes the goal of the course in engineering economy as being one of simple mastery of principles and getting the "hang of" applying them correctly, that is, straight thinking. There comes the choice, come final examination time, to either select quantitative problem examination questions or to resort to essay or true-false question lists to test the student's knowledge of the subject. As a quantitative problem can be so easily all right or all wrong by the violation of a single principle, examination grades using the problem section type of question are likely to be erratic to the extent of raising the question of fairness in the mind of the student and teacher alike. On the other hand the essay type or true-false type of examination indicates knowledge but not what is most desired—the indication of ability to think through a problem with the use of this knowledge.

The problem section type of testing the student is selected because it comes closest to measuring thinking ability. Because of the "all right" or "all wrong" quality of engineering economy principles in application, it is next essential that as much problem section work as possible be carried out to produce a long and reliable record of what the student can actually do. The weekly problem section and a final examination which is graded and counted as merely a continuation of the problem section record serves well to produce the reliable measure sought of each student's ability to think through problems of the engineering economy type.

The D-Level Examination

The problem section philosophy of grading students in a course in engineering economy is excellent for searching out the grasp students may have of the principles taught. Early in the teaching of

* Prepared for the Engineering Economy Conference at the Annual Meeting of the American Society for Engineering Education at Austin, Texas, June 16, 1948.

this subject, the writer noted how often a student when confronted with a problem having some complexity, tended to "heave overboard" the principles he had supposedly learned and to go to work with whatever primeval instinct he had. It seemed advisable to invent something that dramatized the learning of certain fundamental ideas. Because engineering economy is mostly taught to seniors whose failure of the course is fraught with tragic personal adjustments for the student, it was further decided that perhaps the dramatization of the principles should be carried far enough to force each student in the class to prove that he could work straightforward problems illustrating the working of a selected number of principles by the simple expedient of requiring him to repeat the examination carrying this requirement as many times as it were found necessary to accomplish this end. For this purpose the D-level examination was born. Every student in the course is required to achieve the ability to pass such an examination with a grade near perfection. Any minor violation of principle forces a repeat examination.

The D-level examination forces attention to basic ideas and methods, also forces a drill in these basic matters since some students may have to take D-level testing several times. It has however stabilized the whole process of teaching the subject. Because the student is forced to become familiar with basic principles, his performance in problem work shows great improvement. Because the instructor knows that every student at least has demonstrated his ability to work a set of straightforward problems employing basic principles, he is greatly encouraged with the feeling that each student has had a thorough exposure to fundamentals.

The Conditioning Survey

The third important feature employed in teaching engineering economy is the conditioning survey. The average student who comes to the class in engineering economy has for preparation only one or two courses in political economy and maybe not even this. Few have had accounting even in high school. On the other hand mixed in with the group with little or no background are a sprinkling of men whose business literacy is at a high level by reason of numerous courses or by reason of association with their fathers or others in business enterprises of one kind and another. As engineering economy is practiced in a business atmosphere, it takes cognizance of the accountant and his ways of doing things, it also should and does refer to the problem of financing. How can a class of students with mixed preparation be properly conditioned to be ready for the teaching of engineering economy in the professional atmosphere it belongs? There is only one answer that the writer has found—an approach by way of a survey of selected financial matters. The content of this survey is aimed at conditioning the student for the engineering economy work to follow but it is given also with the idea of raising the business literacy of the average student. Because of the unequal preparation of the students, the performance of the individual student during the three week survey period is of little consequence except as a reflection of attitude for each individual student is obtained. The student is assigned tasks during this period which take him to the financial pages of the newspaper and to the financial manuals. He may try his hand as an amateur analyst of the financial condition of some company in which he can find an interest. The survey is a conducted tour which pauses for important details about accounting, financing, budgeting, organization, and promotion, to insure the conditioning desired. It is devoted largely to catching the interest of the student and pointing out fields in which he should have some interest and some professional competence at some later date.

Technical Course Teaching Levels Achieved

As every experienced teacher knows, there is no substitute for a thorough grounding in the principles of a subject

and a thorough drill in the application of these principles. The devices described above have enabled the writer to raise the level of performance in his courses in engineering economy to a point comparable with technical courses. It is believed that this was possible only because the program using these devices aided greatly in obtaining a thorough grounding in principles and considerable drill. The program using these devices provides great opportunity for introducing interesting material and stimulating the interest of the students—this also promotes better performance. Perhaps the writer just likes his own ideas but he believes there is an orderliness and snap to the conduct of a course with these features arriving in succession. To him it represents great progress over the old way of placing the same emphasis on all material covered and testing the student periodically for a measure of the information he has picked up about the subject.

College Notes

Nearly a third of a million degrees were conferred by colleges and universities in the United States during the year ending June 30, 1948. The **Office of Education,** Federal Security Agency, made this announcement in reporting for the first time the actual number of earned degrees of each level (Bachelor's, Master's, ad Doctor's) conferred in each field of study by 1,214 higher educational institutions across the nation.

INSTITUTIONS GRANTING LARGEST NUMBER OF DEGREES

Bachelor's		Master's		Doctor's	
Univ. of California	7,103	Columbia University	4,819	Harvard University	310
Univ. of Minnesota	5,435	New York University	2,200	Columbia University	277
New York University	5,295	Univ. of Michigan	1,912	Univ. of Wisconsin	197
Univ. of Illinois	4,395	Univ. of Chicago	1,257	Univ. of Chicago	181
Univ. of Michigan	3,768	Univ. of Illinois	1,033	Univ. of California	159

Significance of Engineering Costs in* Manufacturing Industry

By EDWARD W. BUTLER

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There can be no doubt but that in this age of rapid scientific advances, our high standard of living in the United States is the result of our free enterprise or competitive system within which engineering plays a major role. So, in preparation for our discussion of engineering costs in industry, I would like to orient engineering in the industrial picture from the standpoint of one who has the responsibility of operating a business at a fair profit.

In a manufacturing industry, engineering is an essential ingredient. It leads to the development of new products, the improvement of old products, lower costs, and other desirable qualities which expand the acceptance and use of a line of merchandise. Such new products, improved products, lower costs, etc., are all directed toward achieving larger sales and greater profits through greater acceptance of the product and are therefore, prime factors in assuring the profits which make it possible to build a bigger and stronger business.

Components of Engineering Cost

In discussing the subject of engineering cost and its relation to profits, I think we should divide it into two broad areas. The first is the cost of forward looking engineering or research. This is really an administrative expense, because it is not applicable to the product on a unit basis. My company, along with other progressive companies, has, over the last thirty to forty years,* developed the philosophy that it is to its best interest to make scientific contributions to the field in which it works, without expecting that the money spent to produce those contributions will return directly and quickly in the form of greater sales and profits. Engineering costs of this kind, therefore, become a top-management gamble on the future. True, there are certain benefits such as prestige, the maintenance of a fund of technical knowledge and the opportunity to build more easily a stronger engineering department through attracting men of higher standing. But such benefits are not directly allocable to specific items on a unit basis and therefore, like other administrative charges, must be spread across the entire field of the company's activities.

The other area of engineering cost is that which results from the development and design of specific products and it is that subject which I propose to emphasize principally, today. By the cost of engineering specific products, I mean not only the time of design engineers but also that of technicians, draftsmen, the cost of maintaining service departments such as a chemical lab, machine shops, model shop, standard and specifications department, etc., and the cost of engineering supervision. All these efforts,

* Presented before the New England Section Meeting, ASEE, Northeastern University, October 16, 1949.

which lead to the development of a specific product, produce costs which are directly chargeable to it.

Engineering Costs as Related to Sale Price

I have spoken of the design of specific products. By that I mean the design of a piece of merchandise which will meet the needs of a customer. Since the product is being designed for a customer he is going to pay for the engineering. Since design engineering cost can be closely determined, each unit will carry a unit engineering cost equal to the total cost of engineering the product, divided by the total number of units sold. For example, if I am in the business of manufacturing radio receivers, I should know from past experience approximately what it will require in terms of design engineers, technicians, draftsmen, machine shop, model shop, standards and specifications, engineering supervision, etc., to complete the development of a 5-tube super-heterodyne chassis. Suppose my experience indicates that this will be in the range of $15,000 more or less. If the sales outlook is for 100,000 units, the unit cost for engineering will be fifteen cents each. Now, let's see how that fifteen cents stacks up with all the other pennies involved.

If the set is to sell for $9.95 retail, the manufacturer's share will be about $6.50. Out of this he will have:

Materials—including completed components purchased from outside vendors	$4.00
Assembly, testing and packing labor	.60
Overhead at 120%	.75
Sales and administration	.50
Engineering	.15
Net margin	.50
Total (manufacturer's sales revenue)	$6.50

Now, by contrast, let's take a $300 phonograph radio combination. In this case, if the manufacturer expects to sell 20,000 of these units and the engineering bill is $50,000, the unit cost for engineering will be $2.50. Because of higher distribution cost, the manufacturer's share of the $300 in this case is only about 45% of the retail price instead of 65% as in the case of the $9.95 set. So he receives $135 out of the $300. This will be accounted for, roughly, on the following basis:

Materials—including completed components purchased from outside vendors	$ 86.00
Assembly, testing and packing labor	10.00
Overhead at 120%	12.00
Sales and administration	11.00
Engineering	2.50
Net margin	13.50
Total (manufacturer's sales revenue)	$135.00

These examples are shown to indicate how many more pennies or dollars the customer will pay in a more complex instrument than in a simple one. The reason back of this all is that the engineering effort expended must be closely in tune with the problem. It would obviously be as ridiculous to spend $50,000 on the design of the $9.95 radio as it would be to spend only $15,000 on the $300 instrument, the reason being that seeking the ultimate in the low price instrument would result in an engineering cost which would make it non competitive price-wise and therefore practically unsalable.

However, if $50,000 spent for engineering would produce savings of $50,000 in materials and labor in the $9.95 set by comparison with competitive merchandise, it would be warranted. If it did not, the additional cost of engineering would have to come out of profit or be recovered in a higher price. By the same token, in the $300 set it would be false economy and bad engineering not to expend required engineering to get a suitable quality product for the market.

This leads me to my next point which is the relationship of the evaluation of the market to the cost of engineering.

Frankly, I do not know that it would be possible along with differential and integral calculus, applied mathematics, courses in mechanical and electrical engineering, drafting, etc., to give engineering students any preparation for the cost problems of engineering. I do believe there would be merit in showing the relationship of engineering to sales, production and distribution in the successful operation of a competitive business. If that could be clarified in the minds of engineering students, perhaps their orientation in industry after graduation would be made more readily and their understanding of the significance of their work would be much greater, because they would enjoy the satisfaction that comes with successful participation.

Deficiencies in Our Educational System

In preparation for our discussion, I have followed the plan of talking to a number of our younger engineering personnel. Because our business in Sylvania is one which is based on engineering progress, we have a continued policy of bringing into our organization every year a substantial number of young engineering graduates to provide the foundation for our technical future.

I have found these young men quite articulate as to problems they encountered upon entering industry, and I shall try to summarize my observations for you:

1. They do not feel that they are well grounded in an understanding of how our competitive system of free enterprise works, *i.e.,* the mechanics by which successful businesses exist.
2. And I think this is most important, they do not consciously recognize the exciting part that as engineers they can play in the perfection and progress of this great system.
3. Their acquaintance with the economics of industry is based on courses which in most colleges are known as Economics I. Such courses deal with the price of gold, trade balances, etc., and may be good introduction for economic students who will go further in that field. But they do not prepare the engineer for his immediate participation in the problems of industry.
4. This probably ties back to their lack of understanding of our free enterprise system. The attitude of many young engineers toward engineering costs is apt to be that they are lowbrow in character, something for the "bookkeeper" to worry about. The feeling exists that the solution to engineering costs is to let them fall where they may, and expect to recover them in high prices by putting on a high pressure sales campaign.
5. They do not have a clear understanding of the relationship of engineering costs to what the customer pays and quite often do not recognize that the customer who buys the product is really the individual who is paying the engineer's salary. Instead, they usually feel that they have only to produce a product of top intrinsic quality and when they have done so, they have done their job well.
6. They feel that the contributions of the sales department are small and that salesmen are people with big expense accounts who smoke long black cigars, drink a lot of liquor and entertain a lot of customers but don't make any appreciable contribution to solving the problems of the business.

I would like to repeat that I am not sure that the engineering curriculum has space to include courses on the engineering cost problem of industry. Possibly it is more efficient to concentrate on developing to the highest degree the engineers' technical knowledge and ability, leaving to a postgraduate course in industry as it were, the economic orientation required to bring the men to the highest degree of ability.

Prerequisites to an Industrial Career

But here are some of the things that it would be helpful to have young engineers prepared to understand and accept when they enter industry. We know from experience that when they do understand them, they readily understand the significance of their work.

1. It would be helpful if they understood that business is essentially a team operation and that each department has certain assignments which when properly carried out, mean that the whole team gains ground.
2. It would be helpful if they understood that in a manufacturing business, it is the job of the sales department to determine by the most scientific and reliable means available, what kind of product the customer wants, what features he prefers, what price he will pay, how many he will buy and when he will take delivery.
3. It would be helpful if they recognized that sales, engineering and manufacturing people try to work out the best combination of features and price which will be most attractive to the customer and result in a fair net profit.
4. It would be helpful if they recognized that customers of an industry have in most cases a free choice of various competitor's products in the market-place, each product vying for his favor.
5. It would be helpful if they recognized that the customer's choice of what he will buy is determined by what he believes he needs, rather than what someone else thinks he ought to have, and that the qualities of the product, *i.e.,* features and intrinsic qualities, its price and the ability to get it when he needs it, are the factors which determine a choice, and not primarily de luxe construction or elegant gadgetry.
6. It would be helpful if they understood that quality, price and delivery are almost always the results of a series of compromises in which the engineering department is a major participant because it is the engineering know-how which provides the most efficient application of material and labor to the task at hand.
7. It would be helpful if they recognized that a group of people we call customers pay the bill for engineering and that if the engineering bill is too high by comparison with competition, the customer cannot afford it any more than he can afford too much material or too much labor.

I feel that perhaps we have not done enough in industry to acquaint those who set engineering academic policies with the things we would like to do to help young engineers become quickly oriented in industry. Neither you in the academic field nor we in industry, are working in a vacuum. A liberal exchange of problems and viewpoints would be helpful. I think perhaps many of us in industry do not know whether the academic field would be receptive to regularly exchanging ideas. Perhaps some of us are afraid of appearing nosey and have been very reluctant to take the initiative. But such an opportunity does exist and may be capitalized. Certainly as far as I am concerned, the desire is there.

May I sum up with these points:

1. That we would all like to help young engineers enter industry more comfortably and progress more rapidly.
2. I believe they could advance faster if they had a clearer conception of the relation of engineering costs to the other essential costs of manufacturing.
3. This understanding could be greatly helped if they had more knowledge of our competitive free enterprise system and how it works and particularly if they clearly realized that the final arbiter of any product is a human customer, not a super intelligence which will analyze and measure every bit and part and process for its intrinsic superiority over all others.

Oak Ridge—The Symbol of Our Unresolved Dilemmas*

By ROBERT M. BOARTS

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Descartes, in introducing his famous book on Method, says this about our common heritage—"Good sense is, of all things among men, the most equally distributed; for everyone thinks himself so abundantly provided with it that those even who are the most difficult to satisfy in everything else, do not usually desire a larger measure of this quality than they already possess."

Flavored slightly with cynicism as this is, it is yet the theory of our democracy and, indeed, of our political practice. Each citizen as an expert elects other citizens as experts to sit in judgment on our complex problems. Daily these problems parade across the newspaper—the color of margarine, the kind of radio program we send to South America, the cost of housing at Oak Ridge, and more. Despite the levity with which we surround the deliberations of our legislative groups these are serious problems and none more so than atomic fission.

It is less than ten years since atomic fission became a reality to scientists; it is less than three years since atomic fission became a deadly reality to hundreds of thousands of people and a cold apprehension to the rest of the world. The science and engineering that built this giant have been acclaimed. The reasonable assumption that now the forces of man would direct the forces of nature to our greater good has been our hope for almost three years but the route has been rocky and the accomplishments, while substantial, have been disappointing.

Technical skill for the task was assembled at the close of the war. If it is not there now, if the succession of changes and counterchanges of policy, direction, operators, objectives have delayed the work, then we can well examine the extra-technical aspects of this nuclear project to find what we might learn for our future welfare.

That the causes for our faltering progress in nuclear fission are complex is obvious. I shall not look for a first cause except to note, idly, that if fission had not been accomplished on Adam's rib there might be no problem today. Rather, I shall examine briefly some of those aspects which can be related to the broader education of our next citizens, particularly the engineers and scientists. To do this, I shall ask some questions, not in order to erect a straw man to knock down or a scapegoat to blame, but as pegs on which to hang discussion. The answers will not be "yes" or "no," they will not be complete, and we can hope only that they will add to our discernment and aid our perspective.

Does the trouble lie with our form of government?

Probably; and we cannot have it otherwise. Every man a king! promised Huey Long, showing a deep understanding of our psychology. Every man an expert, we maintain, as we elect our fellow expert to solve our problems from within himself and by his good sense. De Tocqueville, the brilliant French analyst of our democracy, noted in 1840 this weakness and showed how we derive much strength from it. He says—"To evade the bondage of system and habit, of family maxims, class opinions, and, in some degree, of national prejudices; to accept tradition only as a means of information, and existing facts only as a lesson to be used in doing otherwise and doing better; to seek the reason of things for oneself, and in oneself alone; to tend to

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results without being bound to means, and to strike through the form to the substance—such are the principal characteristics of what I shall call the philosophical methods of Americans."

If our system permits unthinking men to damage this work of unusual importance, then we can repair this damage safely only within the framework of the same system.

Are those who direct the program incompetent?

By usual standards, no. The Project is governed by a non-technical Commission who are advised by a panel of respected scientists. Many of the decisions bear the evidence of the thinking of these scientists and therefore the success or failure of this thinking is of interest to those educating technical students.

The administration of a project such as nuclear energy involves particularly ideas, men, and means. I will deal later with the question of efficiency in finding ideas. The matter of means is not altogether at the disposal of the executives, budget considerations place it on a legislative level. The personnel factor is more important than the other two, for good men will have ideas and find a way to achieve means.

The personnel problem on the Project has not been solved. The loss of good employes has been continuous. We might ask seriously whether scientists are properly equipped to run scientific enterprises. Mills in "The Engineer in Society" believes not. He says—"There is no reason to expect that a creative engineer, by virtue of his mentality, can be an international financier than that an automobile industrialist can be a social philosopher or historian. The more completely a man's instincts are those of a research scientist the less the possibility that he can with equal success be anything else—and that includes being executive in an engineering industry or a government organization of scientists."

If this is true, it would seem to call for a broad education for the engineer who is headed for administration but a specialized education for the research engineer. However, the pressures which force good researchers into administration are so strong that we likewise dare not neglect the broader aspects of his education.

Does our desire for efficiency trip us?

Many of the decisions which have distressed the Oak Ridge personnel have been made in the name of efficiency. These decisions call for consolidation of programs, formal assignment of personnel to specific duties, and more coherent organization. This is the technique for industrial development and it works well for development. Development is what its name implies—it makes useful the ideas of research. Atomic fission was the product of university research conducted without regard for the direction of application. By industrial standards there were many failures in these researches but as Edwin H. Land has said, "A research program is never a failure. Every incident in its history will prove to be an educational factor in the next investigation undertaken."

Because of the equipment and safety difficulties, this problem of promoting the flow of fundamental ideas cannot be settled by sending the project back to the universities in toto. Nor can success be achieved by converting the almost aimless search for new ideas to a streamlined developmental type of machinery. Most research scientists will not work in this atmosphere and they move on. Most research engineers try to work in this atmosphere and that is why there has been so little engineering research done. They are converted to development engineers.

In engineering education, the question is being asked increasingly whether our curricula do not encourage a spurious efficiency which in our graduates manifests itself by a lack of discernment of the relation of the parts to the whole. B. R. Teare in a recent conference on education

for professional responsibility used the phrase "problem-solving-madness" to indicate our over-balance in this direction.

We might ask, then, whether there is any evidence that the scientists and engineers on the nuclear project have ignored the social relations and humanistic viewpoints in their work.

Do scientists and engineers lack a social conscience?

It has been charged many times that scientists and engineers lack a concern for the consequences of their work. If on the nuclear energy project this is true, then it would be expected that morale would be bad merely because of infringement on personal liberties caused by security restrictions. J. G. Crowther, writing in January, 1940, asserts that "Science depends on freedom, but it also depends on social relations, and at the present time the latter are the more important, as they are the less understood."

No one who has seen the earnestness with which the atomic scientists and engineers have endeavored to awaken the country to the significance of nuclear fission can doubt their social conscience. Driven by the grim necessity of getting action, they have attempted to convert themselves to social scientists and so use political paraphernalia to make their point.

It is probable that a better understanding of the social sciences would have clarified their thinking and prevented many proposals for illogical action. Yet at best there was a price to pay, and that was the diversion of able minds from nuclear theory to political theory. Some doubt has been expressed earlier whether this shift could be made efficiently; the fact that many of the minds so diverted were not replaceable could only hurt the work.

Is there a relation between nuclear fission and the humanities?

This is a much more difficult question to discuss for, as Henry Adams says, "words are slippery and thought is viscous." To get around this difficulty I rather like the solution of this problem as explained to Alice when she was visiting in the Oak Ridge of her day. "When *I* use a word," Humpty Dumpty said in rather a scornful tone, "it means just what I choose it to mean—neither more nor less."

To me, the humanities represent the total of man's concern for the individual, social relations look beyond the individual, and science looks to Nature. Each of these commonly used words have elements of the other two to complicate their use. And words I have used already have meanings compounded from these concepts. For instance, we have been talking about research. The spirit of research is almost purely humanistic; the means and laws of research are scientific; and the usefulness of research (or development) is essentially social relations.

From my definitions—oversimplified as they may be—I am led to the thesis that it is possible to dry up the well springs of a great project by too little regard for the humanistic approach. President Conant in his little book "On Understanding Science" has pointed out that the standards for exact and impartial scientific inquiry have, historically, not been set by scientists. He says, ". . . the love of dispassionate search for truth was carried forward by those who were concerned with man and his works rather than with inanimate or animate nature." If we say that, in recent years, scientific method has given science the clear road to the fountain of truth, we will find that du Noüy, the brilliant bio-physicist who died last year, has arrayed powerful arguments against this view in his book "Human Destiny."

Thus I am led to a restatement of the position I have already taken, that the haste and search for efficiency have already militated against the flow of new ideas in atomic fission. To those who point to the accomplishments of the wartime mass effort, I can say only that the

Manhattan District inherited most of its stock of fundamental ideas and developed them into a bomb. Ideas can be stockpiled as well as bombs but it is harder to estimate the size of the pile.

What is the time-dependence of these problems?

The objection may be raised that the arguments I have presented are academic, that the dilemmas have been resolved for us by the urgency of the times. It is probable that there must be short range and long range solutions to these problems, and the unrest in the world disposes us to emphasize the immediate. This has always been so. Possibly speed may be gained by haste in our national decisions, pressed as we are by outside influences. De Tocqueville, in his keen perception of our way of doing things, prophesied in 1840 that a hundred years later we would still be nurturing this problem. He says: "I am convinced, however, that if the Americans had been alone in the world, with the freedom and knowledge acquired by their forefathers and the passions which are their own, they would not have been slow to discover that progress cannot long be made in the application of the sciences without cultivating the theory of them; that all the arts are perfected by one another: and, however absorbed they might have been by the pursuit of the principal object of their desires, they would speedily have admitted that it is necessary to turn aside from it occasionally in order the better to obtain it in the end."

Turning from the consideration of the possibility that the short range solutions and the long range solutions may be identical, we can ask one final question. Can any solution be correct which ignores the moral and spiritual aspects? I have carefully avoided using those terms up to now because I believe that it is impossible to discuss the dignity of the individual, the welfare of mankind, and the manifestations of physical laws without presupposing a common binder for our activities and a higher purpose for our actions. In times of stress, the purpose seems obscure and, because we lose our perspective, we judge our progress harshly, I am afraid that I have been guilty of this error in these discussions. If so, I will state again that it has been my only purpose to examine some extra-technical aspects of a mighty project so that we could educate our youth more wisely. Du Noüy has painted his optimism of our position in broad strokes of centuries but I believe we can see progress even in terms of years.

"Humanity under the influence of such events as wars, or as a result of the necessity to adapt itself to the changes brought about by mechanical progress and the ensuing social problems, reacts violently by twists of the helm which seem to carry it far from its course. But the transcendent laws it unknowingly obeys have brought it in less than a thousand centuries to its present state and scorn these ephemeral digressions which become imperceptible on the scale of evolution. Like the ship constantly kept on its course by the pilot who corrects its deviations, humanity may seem to hesitate and waver; however, it will infallibly reach the port which is at the same time its goal and its reason of existence."

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College Notes

The 16th Annual Report of the **Engineer's Council for Professional Development**, a conference of engineering bodies organized to enhance the professional status of the engineer, features several reports indicating the progress made last year by ECPD committees. There are four major committees: one each on Student Selection and Guidance, Engineering Schools, a committee on Professional Training, and a committee on Professional Recognition.

Chairman, J. W. Parker, of the Detroit Edison Company, pointed out that the Committee on Student Selection and Guidance distributed pamphlets and posters this year to no less than 10,000 communities for the guidance of high school pupils about to enter engineering.

Other reports show that another committee of ECPD studied and issued a pamphlet on methods of testing engineers. It is published under the title of, "The Most Desirable Personal Characteristics."

Three new colleges were accredited by this group during the past year.

Colloid Chemistry in the Chemical Engineering Curriculum

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The general aim of education is to enable one to live more effectively. The specific purpose of a specialized technical education is to enable one to contribute the most to human welfare, particularly in a specific field of knowledge, and to earn a satisfying living. The engineering and scientific curricula should therefore be so designed as to accomplish these aims most efficiently. One of the subjects commonly neglected or underemphasized in most chemical engineering or chemistry curricula is colloid chemistry. This paper offers suggestions regarding the teaching of this subject, many of which are applicable to the teaching of other engineering and scientific subjects.

Justification for teaching colloid science is readily obtained by observing the number of times which everyone everyday comes in contact with colloids and colloidal phenomena and in the importance of these contacts for human welfare. Alexander Pope in his "Essay on Man" proclaims that "the proper study of mankind is man." If this statement is accepted, no further justification need be given for the study of colloidal science. Man himself, like all living things, is composed of colloidal materials and the reactions of life are in large part interactions of these colloids or colloidal systems with ions and smaller molecules as well as with themselves and other materials in the colloidal condition.

The chemical industry has a particular interest in colloids. Many industries manufacture colloidal products from colloidal raw materials, including most substances of organic origin. These include the manufacture of rubber, bitumen, rayon, textiles and dyed goods, paper, wood products, nitrocellulose, tanned leather, gelatin, glue and photographic materials, lacquers, varnishes, fermented beverages, butter and dairy products, many other foods, ceramic products and drilling muds. Other industries make colloidal products from non-colloidal raw materials. This group includes the manufacture of resins, plastics, soaps, various types of synthetic detergents, lubricants, inks, cements, glass, alloys and the silicious soluble silicates. In many other industries processes involving colloidal phenomena play an important role. These processes include smoke and fog "abatement," demulsification of oils, the coagulation of raw and waste waters, and sewage, flotation as in the concentration of ores, purification or separation of various materials by absorption, and water softening.

Because of the present crowded curriculum it is probably too much to expect that every newly graduated chemist and chemical engineer will have taken a college course dealing specifically with colloids, desirable though this may be. However, every chemist and chemical engineer should know at least what colloids are, their main characteristics, and have an idea of what colloid science can and does do. Much of this can be and is taught in other courses in the usual chemistry curriculum. In the general or inorganic chemistry course, there should be a discussion of the definition of colloids,

their preparation, and some of the most important properties of a few of the more common colloids. At least two lecture periods and one laboratory session during the year can be profitably spent on colloids without fear of overemphasizing the subject. The pandemic or "cultural" chemistry course for students not majoring in the physical or biological sciences offers an excellent opportunity for teaching colloid chemistry. This course should contribute to the student's understanding and appreciation of his environment. Since most of the everyday objects, materials and processes with which everyone comes in daily contact are colloidal, one's environment cannot be understood without knowing a few of the basic principles and experimental facts of colloid science.

Courses in quantitative and qualitative analysis should teach the conditions necessary for forming flocculent, amorphous, gelatinous or crystalline precipitates. Some analytical reagents are colloidal and several analytical procedures involve the formation of colloids, such as color lakes. In other procedures special care must be taken to prevent their formation. Adsorption indicators and errors due to adsorption or peptization are important colloid chemical topics for the analytical chemistry course. Organic chemistry courses discuss proteins, starch, cellulose, polyuronides, hemicelluloses, tars, resins, plastics, dyes, soaps and synthetic detergents—all of which are colloids. In order to deal with these most effectively, the organic chemist should know the basic principles of colloid science. The teaching of colloid science in the biochemistry or physiological chemistry course is well illustrated by R. A. Gortner's textbook "Outlines of Biochemistry." His book devotes a substantial proportion of its contents to that subject. The physical chemistry course should teach some of the physicochemical principles of colloidal phenomena both in the lecture and in the laboratory.

Some of the facts and a few of the techniques of colloid science can be learned in these other courses. However, the knowledge thus obtained cannot be expected to be as adequate to utilize colloid science in industrial problems or in other applications as is desirable. As many chemists and chemical engineers as conveniently can should take a separate course in colloid science. This should consist of at least 36 one-hour lectures and preferably more.

Colloid science may be taught from several points of view. The physiological viewpoint is illustrated by the work of Wolfgang Pauli, and Jacques Loeb whereas that of the organic chemists is illustrated by the studies of Carothers, Meyer and Staudinger. Since colloids may be defined as particles one or more of whose dimensions is from 10 to 10,000 Å (10^{-7} to 1^{-4} cm.), their study may be approached as an extension of the properties of larger bulk matter to these dimensions. This is a usual approach in studying the properties of lyophobic colloids by comparing their properties with those of a solid wall immersed in water. This treatment has been developed during the past 25 years by concepts of "capillary chemistry." Another approach is to study the behavior of colloids as an extension of the behavior of small ions and molecules to molecules of larger dimensions and colloidal aggregates. This method can be called the physicochemical approach to colloid chemistry. This is the method so successfully applied to the study of proteins in recent years and to the study of soaps and detergents by Prof. J. W. McBain and collaborators and others. In fact some of the most interesting colloid chemical research of recent years such as Linus Pauling's work on antigen-antibody reactions, and work at Harvard by E. J. Cohn's group and at the University of Wisconsin by Prof. J. W. Williams and coworkers on proteins may not generally be regarded as colloid chemistry. All of these different viewpoints should be represented in an adequate course on colloids.

The author believes that the physicochemical approach to colloid science offers the best way to begin the study of this subject for most students. In most cases he or she has recently completed a physical chemistry course and the concepts and techniques just learned can be applied to the study of those colloids amenable to such treatment. Such an approach to the subject should assist the student in relating the subject of colloids to physical chemistry and other scientific fields and in integrating the new knowledge into a unified concept of the constitution and properties of matter. When the student has acquired some familiarity with the physicochemical approach, it can then be pointed out how the laws of classical physical chemistry are inadequate to explain the behavior of all colloidal systems. This naturally leads to a study of modifications of these laws for colloidal systems and to a study of those laws and hypotheses unique to colloid science.

The first, although not necessarily the most important, function of the course in colloid chemistry is to teach the basic principles of that science. Answering the question "what are colloids?" is a suitable beginning for such a course, and may involve a brief discussion of the types of colloids encountered, and the history and literature of the science as well as the customary definitions. The answer to how colloids are obtained involves, of course, a discussion of methods of preparation.

Recent developments in such techniques as X-ray and electron diffraction, light scattering, ultra-microscopic technique, the electron microscope and others have made it possible for us to know with a fair degree of accuracy and some certainty the size, shape and structure of some typical colloids. This, plus the newer knowledge on the nature of the forces between ions, atoms, molecules and particles, makes it possible at least to try to explain the properties of colloids in terms of their size, shape, and structure. Once the anatomy and morphology of a system is known it is much easier to understand its physiology or functioning. Of course, determining sizes and shapes of colloids involves a knowledge of at least some of their properties. It is a pedagogical problem to determine which properties shall be used to illustrate how size and shape are determined, and which shall be used to show how various properties may be predicted or understood in terms of a known size or shape. At any rate, the student should know on completing the course how the various properties are used to determine size and shape, and conversely how the behavior of the colloid is predicted or understood on the basis of a known structure.

Because colloids have a large ratio of surface area to total volume, their most characteristic property is that of sorption or interaction at surfaces. The colloid chemistry course then should involve consideration of such topics as surface and interfacial tensions, the factors influencing the sorption of gases and vapors by liquids and solids, sorption of electrolytes and non-electrolytes from solutions by polar and non-polar adsorbents, sorption isotherms, isobars, isosteres, and heats of sorption, physical and chemisorption, measurements and explanations of sorption, surface films on liquids, molecular and ionic or exchange absorption and methods for determining surface areas. Industrially important processes which illustrate sorption phenomena are purification by adsorption, contact catalysis, chromatography, adhesives and lubrication.

Consideration of the optical properties of colloids involves study of the Faraday-Tyndall effect, light scattering, the Rayleigh and Mie equations, refraction, flow and intrinsic birefringence, polarization and depolarization phenomena, dichroism and dityndallism, the ultramicroscope and the electron microscope. The colligative properties such as osmotic pressure, the Brownian movement, diffusion, sedimentation, ultrafiltration, dialysis, solvation and

viscosity of colloids have both theoretical and practical importance and certainly deserve study in any colloid chemistry course. The electrical properties of colloids should be discussed in terms of conductivity, transport numbers, the four types of electrokinetic phenomenon, the Helmholtz, Smoluchowski, and Gouy formulations, the eta and zeta potentials, and the charges and mobilities of colloid particles, and their relation to the stability of colloids.

Once the properties of the colloidal particle itself are understood, its interactions with like colloids and other ions, molecules, and different colloids can be studied. These interactions involve aggregation, coagulation, sensitization, protective action, coacervation, and the electroviscous effect. Other topics which merit study in a colloid chemistry course are emulsions and foams, aerosols, gels, jellies and the sol-gel transformation, Donnan or membrane equilibria, swelling, dilatancy, rheopexy, colloidal electrolytes, and the lyotropic series. Special colloidal systems which would be profitably studied briefly if time permits include plastics, resins, rubbers and other synthetic high polymers, proteins, colloidal carbohydrates, clays and hydrous oxides or silicates.

A very large proportion of the significant developments of colloid science during its entire history have been due to the application to these systems of new tools and techniques. Advances were made possible by using ultramicroscopes, osmometers, X-ray and electron diffraction techniques, electron microscopes, ultracentrifuges, and light scattering apparatus. The student should become familiar with the theory and operation of these tools, preferably by actual contact in a laboratory. Certainly numerous lecture demonstrations should be given throughout the course to give the student a familiarity with the actual appearance and behavior of all the representative types of colloids. Tours of local plants manufacturing or dealing with colloids and talks by industrial chemists on practical applications of colloid science could advantageously supplement the regular lectures.

The most apparent purpose of colloid chemistry courses, as of other courses, is to teach a factual knowledge of the subject. However, this can be obtained from books. There should be and are reasons for giving lecture, demonstration and laboratory courses. It is well recognized that one's success in industry and other pursuits depends at least as much, if not more on his personal attitudes and characteristics as on the amount of factual knowledge which he has accumulated. The second object of the colloid chemistry course is therefore to assist the student in obtaining those attitudes and personal qualities of most use to him in his scientific work.

From his study of leaders in science, business, government, art and other fields the French scientist, Henri LeChatelier, concluded that the following four factors, listed in the order of importance, were necessary to success in every endeavor—enthusiasm, judgment, imagination and a large fund of organized knowledge. Enthusiasm for colloid science is best imparted to the student if the teacher is himself enthusiastic about his subject and if it is presented in an interesting, challenging and stimulating manner. To impart good judgment about the many hypotheses and complicated behavior of colloids is a difficult task. Again the teacher himself must possess this quality. A prerequisite to good judgment is a tolerant skepticism of what we presume to know and a realization that we ourselves can become competent to decide what is reliable and unreliable, or what is true and untrue. Scientific laws or principles should not be taught as unquestionable, clearly and perfectly understood, and of everlasting validity. It is particularly true in colloid science that what laws and principles we do have now are the result of human thinking which is not infallible and which all too

frequently is based upon limited evidence and subject to change and modification. Such changes do not necessarily mean that our previous concepts were untrue—frequently they were only imperfectly understood. Judgment involves a critical analysis of all available evidence, a careful weighing of its reliability, and a comparison of its relative worth, necessarily based on past experience. The present theories, laws and hypotheses of colloid science should be taught from these points of view.

From imaginations come the new ideas, principles and techniques which contribute so much to the advancement of colloids and other sciences, develop new products and build new industries. Faraday in his diary states "let the imagination go, guiding it by judgment and principle but holding it in and directing it by experiment." To cultivate and stimulate the imagination and thinking of the student is again a very difficult task, and probably can most successfully be done by a teacher who himself possesses these qualities to a high degree. In fact by far the most important single factor in any successful course is the quality of the teacher.

James B. Conant states that science can best be understood by laymen through a close study of a relatively few case histories which illustrate the tactics and strategy of science. Such an approach could to some extent at least be profitably applied in teaching colloid chemistry. Suitable case histories should illustrate the influence of new techniques of experimentation and connection with the practical arts, and the evaluation of new concepts from experiments. They should also show the difficulties of experimentation, the significance of the controlled experiment and the necessity for eternal vigilance in interpreting experiments. Brilliant generalizations should not be overemphasized. Lastly, a suitable case history for the laymen should illustrate the development of science as an organized social activity. This last requirement is desirable but not necessary for a colloid chemistry course. Unfortunately, there are apparently no case histories on topics of colloid chemistry which have been prepared from this point of view. Many topics dealing with colloids are eminently suitable for such a presentation.

A most important aim of the colloid chemistry course is to teach the student to think effectively so that he may utilize his knowledge in solving problems arising from his environment. The maxims, "learn to do by doing" and "practice makes perfect" apply. Giving the student problems of all types to solve, should assist him in learning effective thinking. Problems obtained from practical situations and the equations now being used in the study of high polymers are particularly suitable for this purpose.

Because colloid science covers such a wide range of techniques and important industrial operations, it can, if properly taught serve admirably to introduce a student to the scientific attitude and method, and to research techniques. Karl Pearson says "the true aim of the teacher must be to impart an appreciation of methods and not a knowledge of facts." Progress in colloid science has resulted from two types of research. First, systems of high purity and the greatest possible simplicity have been investigated to ascertain general laws and second, naturally occurring systems have been studied to find out their properties. There has been a tendency to believe that really good significant research can be done only on highly idealized systems free of complicating details. In this way results can be obtained which are easier to interpret and from which sound generalizations can be made. However, for several reasons it is important and possible to carry out equally valuable research on materials as they actually occur or with minor modifications. Frequently this is the only way to obtain practical, useful results within a reasonable length of time with available facilities. If only

highly purified systems are studied, theoretically significant and practically useful results, such as the large effects of relatively small amounts of some additives and synergistic effects, may be overlooked. The two types of research are complementary and both are necessary for a complete study.

Frequently teachers are criticized for overemphasizing pet subjects in their courses. While this is a valid criticism for elementary courses, I do not think it applies equally to the more advanced. I believe that it is actually desirable for a teacher of an advanced class to emphasize in his lectures subjects in which he has a particular interest or research experience. Some attempt should be made, however, to balance the various topics of the course by outside reading on the part of the student, or else to give the course a title more closely descriptive of the subject matter it covers. The stimulation, inspiration, and better understanding of methods and attitudes as well as facts which students obtain from hearing an able teacher and research worker lecture on his special interests justifies spending some additional time.

Lastly, I believe the course in colloid chemistry can and should, like other courses, contribute its proportionate share to the aims of a general education. A Harvard committee has defined these aims as to enable one to think effectively, to communicate thought, to make relevant judgments, and to discriminate among values.

The requirements of a colloid chemistry course may be summarized by stating that it shold impart factual knowledge, contribute to the development of technical skills, teach scientific attitudes and methods and contribute to the attainment of the aims of a broad general education.

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Pertinent Reading for Engineering Students and Science Majors—the Middle Ground*

By W. T. CONKLIN

Department of English, University of Texas

Thomas Henry Huxley, speaking in October of 1880, at the dedication of the Josiah Mason Technical College, faced squarely a problem still of interest to teachers of scientific and technical students. "An exclusively scientific training," he said, "will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for the ship's being out trim; and I should be very sorry to think that the Scientific College would turn out none but lop-sided men."

The teacher of English can go far in promoting this cultural balance for the technical student by taking advantage of the materials available for instruction, if only he recognize and appreciate what I shall call the literature of the Middle Ground.

I

Before explaining what I conceive this literature to be and what use I plan to make of it, I shall explain my own interpretation of the term *cultural*, as I employ it in this paper.

Is it, as I have recently heard suggested, applicable to any course taught outside one's own department, not required for a degree in one's own department—presumably useless, therefore cultural? Or is it applicable only to courses far removed from one's own department or specialty—courses to be reached only by an intellectual leap into languages, philosophy, and literature? No one, surely, will deny the technical student all the aesthetic broadening his usually crowded curriculum permits.

If, however, cultural expansion involve, as I believe it should, the establishment in the student's mind of the relationships between his own department and the rest of living, especially as these relationships are revealed in the histories and biographies of his own and allied sciences and technologies—in short, in the imaginative and creative backgrounds of his own specialty—there then exists for the teacher of English a great body of literature which, correlated with English and American Literature, will afford transition from the student's interest in science to his interest in literature in the more restricted sense. This source upon which I would draw recounts the history of science, either in the words of the scientists themselves or in those of the most able expounders and reporters of scientific progress. It reflects an aspect of history that is receiving more and more attention.

This literature, proper reading for science majors and engineering students, constitutes the Middle Ground. The teacher of science or technology has little or no time for it; the teacher of English, unless by some accident his interests incline toward science, never discovers it.

That this inclusion of pertinent reading within a course in English taught especially for scientific and technical students will serve a definite and utilitarian purpose becomes clear when one considers the timid attitude of the sophomore in a

* Presented before the English Division at the Annual Meeting, Austin, Texas, June 14–18, 1948.

technical department toward scientific information in another department than own, or even in his own. He at once manifests a mistaken worship of a specialty, before he has acquired a smattering of general scientific knowledge.

When and where this awe of science is engendered, it is difficult to say; but today, when every effort is made to familiarize the common citizen with the nature and implications of scientific development, it is ironic indeed to encounter the narrowly specialized sophomore.

The teacher himself need be only an alert and actively interested layman to utilize the literature of the Middle Ground, making the student aware of a world to which none of his regular courses will take him and developing for the future specialist a new and fresh relationship between the sciences and what his instructor has always known as Literature.

II

This mildly Utopian union of English and the Sciences is suggested at the sophomore level or above, with regular freshman composition as prerequisite. Two courses concern us:

1. An integrated course in literature and science.
2. A report writing course for science majors and students of engineering.

III

I shall first consider the need for what I have just termed the integrated course. My objection to the arguments of those who would teach literature for its own pure sake is that literature, not having been created in a vacuum, cannot and should not be taught in a vacuum. Efforts to teach students, who have not yet the remotest conception of the role of literature, the purely aesthetic pleasures of poetry, prose, and the drama, without attention to the authors or their times, are futile and misdirected.

But why should this be the province of the English teacher? If he set out upon this task of saving literature from being taught in a vacuum, will he not then feel it his duty to usurp the ground of every other department, even as the compilers of freshman readings give us anthologies of sociology and government? I see little little danger of this sort of encroachment; the material which I propose to incorporate into English courses for engineering students and science majors is not available to them in any of the courses they regularly take or elect.

The teacher of English has an exceptional opportunity to serve both the student and the craft. Efforts have been made to establish courses in which fragments of the works of great authors, or even of lesser authors, have been used to illustrate the relationships of the authors to their times and to scientific progress. Two difficulties become immediately apparent, in so far as the fate of literature is concerned: for example, a fragment of poetry, showing Milton's adaptation of the theory of spontaneous generation, will very probably arouse slight interest in the student's mind; even if it does, it is a curious path to appreciation of Milton. Second, the selections from lesser authors, often even more fruitful of scientific allusion, also consume time that could more profitably have been spent reading either great literature or important scientific items. These fragments aren't literature and they aren't science.

To serve our purpose the literature course must be so integrated with readings from the history of science as to accomplish two things: (1) It must acquaint the student with significant works in English and American Literature, thus maintaining its personality as a course in literature. (2) It must introduce him to adequate selections from the history of science, so correlated with the literature that, with the aid of classroom instruction, a clear and definite chronology of literary and scientific evolution will be apparent. Properly presented, the course should demonstrate not only the impact of scientific ideas upon literary minds, but the equally significant and often more important delay in acceptance of scientific ideas.

IV

The problem of securing suitable texts will depend for its solution upon the length of the course. If one allow a year for the literature-science integration, he may then make use of the numerous separate and complete units that are becoming increasingly available in the various series and "libraries." That is, he may readily do so for the literature itself. For the reading material in the sciences he may still have to rely on one anthology or another, in order that texts not become too many or too expensive. One can only hope that more reprints in series like *Everyman's Library*, which again provides such authors as Darwin, Huxley, Lyell, and Tyndall, will soon appear.

If, however, the literature course must be compressed within the space of a semester, an anthology of English and American Literature, together with an anthology of scientific selections, will have to suffice. Good anthologies of science are easily found. There are, for example, Shapley's *Treasury of Science*, Knedler's *Masterworks of Science*, and, though I shall mention it again in connection with the writing course, Moulton and Schifferes' *Autobiography of Science*.

V

Pertinent reading for the writing course presents slightly different problems. Besides including practice in scientific exposition, leading to the preparation of the full-length term report, this course will make extensive use of library books and periodicals; but this reading will not be done merely for the collection of data for the term report. A large amount of this work will become the matter of class discussion by the individual student, thus effecting a continuous integration of classwork and outside assignments.

In the writing course questions of chronology are less important than those of determining just what reading is pertinent, *i.e.*, what reading, considered from the point of view of scientific or technical difficulty, can reasonably be expected of the student.

With the Middle Ground Literature used in the Literature-Science course this problem seldom arises. It makes, as a rule, little difference what the scientific topic may be. The college sophomore can read, with very little discrimination on the teacher's part, the scientific contemporaries of Milton and Pepys. His high school science has carried him beyond the physical knowledge of the Seventeenth Century. But the student in the writing course, though he will be required to read in a condensed source-book, such as Moulton and Schifferes' *Autobiography of Science*, must also read current books and periodicals. He must, of course, be taught good research habits in the gathering of data. He must be made to frequent the science shelves of the general library and the shelves of his departmental library, reading as advanced materials as his scientific training permits.

The popular books and magazines, he will soon discover for himself, are too limited, vague, and repetitious. Scientific and technical journals, on the other hand, are frequently so far beyond his comprehension that they convey nothing, even though he put forth a sincere effort to understand them. This difficulty will, obviously, vary with subject and article.

There then remains a somewhat different type of Middle Ground reading—a type that has multiplied rapidly since August 1945 and deserves a better name than *semi-popular*. Perhaps *semi-scientific* more accurately describes it. The semi-popular verges usually on the popular and is pure journalism, designed to make Babbitt aware of nuclear physics. The semi-scientific is seriously designed to clarify for educated men and women significant developments in science and technology, notably scorning the sensational as an instrument of exposition. To illustrate: There was the great outpouring of hastily begotten journalism that followed Smyth's *Atomic Energy for Military Purposes*—a physics major can read the report itself more profitably than he can its journalistic offspring. On the other hand, Einstein and Infeld's *Evolution of Physics*,

read carefully by an intelligent sophomore, will introduce him to a splendidly written explanation of the method of scientific thought. There are many others equally profitable. And, in order that the student in the writing course may be encouraged to read widely among them, he must be given a list of parallel reading, including histories of science and technology, upon which he may be assigned special reports.

Among the periodicals, the student not yet well along in his major will have better luck in the science shelves of the general library. The articles in *The Scientific Monthly,* for example, will furnish him excellent examples of the clarity possible in authentic scientific discussion. If he is more advanced, he may be able to read articles in the weekly journal, *Science;* if he can read these, however, he can read the professional journals. For the sophomore one of the best Middle Ground periodicals is *Science News Letter,* including, as it does, items from the many meetings of the various societies, and remaining simple though authentic. *Scientific American,* in its new form, should prove useful, though it is still too early to judge. True, my last two examples are for laymen. The student is a layman; his English teacher is sure to be one.

VI

What, then, must be the teacher's qualifications, besides a few years' experience in teaching composition and literature?

He must be alert—an actively interested layman; he need be neither scientist nor engineer, regardless of the conviction that he should be, on the part of those who have found it distasteful to teach future scientists and engineers. Surely he should possess an elementary knowledge of the sciences, based, let us say, upon two years of college physics, two of chemistry, mathematics through elementary calculus, geology, zoology, or any other courses in the natural or physical sciences that a student would elect to take if he were endowed with a genuine interest in science.

But he must, above all things, enjoy reading and keeping abreast of the general scientific news as he can read it in the periodicals. He must also maintain an active liaison with his colleagues in science and engineering.

If the instructor will exert this effort to integrate the student's writing with material bearing directly upon the student's special studies, and if, in his literature course, he will present science and literature as corresponding expressions of human progress, he will do much for the craft and himself develop a deep respect for the Literature of the Middle Ground.

Relations Between Engineering Schools and Secondary Schools—Admissions

By T. P. BAKER

Principal, Austin, Texas H. S.

The problem of admission of the high school graduate into the school of engineering is one that we secondary people are definitely interested in. We could spend a great deal of time discussing the Eight Year Study, or giving a report of the conference on Higher Education that was held recently in Chicago or the reports of other studies, but my discussion will be based upon personal experiences as I have encountered this problem. My experience has extended from the small high school of fifty students to the one we are now principal of, which enrolled over 2800 students this past year. We hope that you can see in the brief discussion that is to follow the practicability of the various statements that will be made.

A few years ago the high school consisted of a group of students who were definitely planning to go to college. The student who was not college material was soon eliminated. Today the high school is a heterogeneous group having all kinds of interests, backgrounds, and abilities. Of today's high school student body only some 17 per cent will go to college. Of the 17 per cent who go to college, the vast majority will enter a liberal arts institution. The high school has had to broaden its curriculum to care for the needs of this 83 per cent who are not going to college as well as to care for the 17 per cent who will.

There are some other factors that enter into this problem of preparation for admission to colleges of engineering, as well as other types of higher educational institutions. During the past eight years there has been an increased interest in engineering by high school students. We are confronted daily by students who say that they are planning to enter some engineering college when every record we have shows that these students cannot master mathematics and science. In a city like Austin this problem is much more pronounced than in many other cities. We have the problem of keeping these students in school on the one hand and directing them into other fields of work on the other. We can do pretty well with the students but Mom and Pop prove a little difficult at times.

We have a fair counselling department, but many students do not make up their minds as to the profession or trade they want to enter until late in their high school career or even after they have finished high school. Many times it is too late for these students to secure the necessary mathematics and science needed for entrance into engineering school. Then the high school is criticized by the college, by the parent, and by the student. Yet, it would be foolish for us to require all students entering high school to take courses in such sequence that all would come out with the advanced courses in mathematics and science needed for entrance to your institutions.

* Presented at the conference of the Committee on Secondary Schools at the Annual Meeting, Austin, Texas, June 17, 1948.

What do we, as secondary school people, think are some of the answers to these problems? We shall attempt to list a few of these but not necessarily in the order of importance.

1. This society could well furnish the high school with information as to the opportunities in the fields of engineering. We have been in a boom period. Will the need for great numbers of engineers continue or will the profession become over crowded if this interest in engineering continues. Are there some branches of the profession that are now undermanned? We think that our students need the benefit of your thinking along these lines.

2. Connected directly with number one above is our belief that the high school guidance program should be more effective. One of the ways that this could be brought about is by having a close working relationship between the high school guidance service and the schools of engineering or of this society. I believe that I am correct in saying that the majority of your schools give aptitude tests during the first semester that a student is in your school. Why not make it possible for our guidance department to request and receive from you these tests to be given interested students in their sophomore year of high school or as soon thereafter as he shows any interest in the field of engineering. By having these tests come from the college itself and sent back to the college for scoring the results would carry much more weight with the students concerned than if we secured the tests from a publisher and attempted to show the student that he was or was not likely to succeed as an engineer. Those showing an aptitude for engineering could be placed in courses in high school that would be of greatest benefits to them. Those not having this aptitude for engineering could be more easily directed into other patterns.

3. We believe that the final requirement for entrance to the school of engineering should be based upon aptitude and general cultural examinations instead of specific units. When you take into consideration the differences in schools, in teachers, and in students it is our feeling that a good aptitude and general culture examination will show more than any transcript can ever show.

As we bring this short report to a close we cannot help but wonder if the engineering school does not have a responsibility for the student who has the aptitude but lacks the specific training of advanced high school mathematics and science? If you had these students in classes composed of only those interested in preparation for engineering, would you not be able to do a better job in giving them the specific skills needed than can we in the high school where classes are not composed of special interest groups? The law schools, medical schools, and seminaries now require a two, three, or four year pre-training period before admitting students. Could not the schools of engineering do this? Every year we have many students from the University who come to us and want to get into physics or solid geometry classes. We feel that you can care for these students better than we can.

In closing, we must not lose sight of the fact that the high school has the responsibility of preparing every student possible to take his place in a democratic society. The high school has to content itself primarily with general education, leaving the specialized training to higher institutions. By being able to center on general education we can, in the long run, send you better students and better citizens.

Minutes of Meeting of the Executive Board

A meeting of the Executive Board of The American Society for Engineering Education was held on Tuesday, April 19, 1949, at Northwestern University. Those present were: C. J. Freund, *President*, F. M. Dawson, B. J. Robertson, Thorndike Saville, S. S. Steinberg, A. B. Bronwell, D. Isebrands, and M. Strohm.

Report of Secretary

The Secretary reported activities of the Society as follows:

1. About 1000 copies of the report "Recommended Procedures in the Interviewing and Placement of College Seniors" prepared by the Committee on Ethics of Interviewing Procedures have been sent to college administrators and industrial personnel men throughout the country. A number of favorable comments have been received.
2. The membership campaign has resulted in 932 individual members this year, 840 of which were from faculties and 92 from industries. Four new institutional members have also been added.

In reporting for the Treasurer, the Secretary discussed the third quarterly financial statement. A 20% increase in cost of publication of the JOURNAL, effective with the January 1949 issue, will raise the publication costs above the budgeted figure. However, the advertising income will also be above the budgeted amount, and it appears as though the Society should be able to avoid a deficit in the year's operations. The new schedule of increased advertising rates has been sent to all advertisers in the JOURNAL.

The Secretary also called the Board's attention to the proposed bill in Congress for increased postal rates which, if passed, would add an estimated $2300 to our annual postage bill.

Report of E.C.A.C.

Vice President Steinberg presented his report on the activities of the E.C.A.C. as follows:

1. The E.C.A.C. has prepared new by-laws which have been submitted to the ASEE Committee on Constitution and By-Laws for approval.
2. The final report of new and proposed building construction has been prepared.
3. The final report of the Faculty Salary Study Committee will be completed at the time of the annual meeting.
4. Plans have been completed for the E.C.A.C. general session and conferences at the annual meeting.

Report of E.C.R.C.

Vice President Dawson presented his report on the activities of the E.C.R.C. as follows:

1. The first publication of the E.C.R.C. for this year entitled "Telling the Story of Research" will be available in a few weeks. It is expected that the sales of this volume will pay for the cost of publication.
2. The biennial "Directory and Review of Current Research" will be available by the time of the annual meeting.
3. Plans for the general session of the E.C.R.C. are being completed. This session will be devoted to the subject of research and instrumentation, and it is planned to have an exhibit at the annual meeting.

Divisions and Committees

Vice President Saville reported on the plans of the Committee on Junior Col-

leges for a conference between faculty members of junior colleges and engineering educators at the annual meeting. The Board voted to heartily encourage and cooperate with both the junior colleges and technical institute groups in urging that they become an integral part of Society activities. The Executive Board would like to call the attention of the junior colleges to the need for a differentiation between the first two years of a conventional four-year curriculum as offered in some junior colleges and the terminal program as offered in others.

In response to many letters received by President Freund and Vice President Saville, the Board authorized the creation of an interim committee of younger members to explore areas of interest and organize sessions, conferences and other activities specifically for younger members of the Society. Professor F. L. Schwartz was appointed Chairman of this Committee. This interim committee is to prepare recommendations to be presented to the Executive Board and General Council.

Future Annual Meetings

The Board voted to adopt the geographical schedule for rotation of annual meetings, but recommended that this schedule is not to be considered binding on future Boards, but is merely a guide in the selection of colleges for future annual meetings.

Fall Meetings

The Board voted to hold the annual fall meetings of the E.C.A.C., the E.C.R.C., the General Council, and Executive Board at Kansas City on Saturday, October 22, preceding the Land-Grant Colleges Association meeting, if this will not conflict with the schedule of the Engineering Division of the Land-Grant Colleges Association. The Secretary will communicate with Dean Green regarding the suitability of this date and will make further necessary arrangements for these meetings.

Constitutional Amendments

The procedure for handling the constitutional amendments proposed by the Committee on Constitution and By-Laws was discussed. Copies of the proposed amendments as passed by the Committee will be mailed to members of the E.C.A.C., the E.C.R.C, and the General Council. A vote on these proposed amendments will be taken by the various Councils at the annual meeting in June. This will then be followed by a letter ballot of the Society membership.

The Board unanimously passed a motion recommending to the three Councils that Article X, Section 2, of the proposed constitutional revisions be amended to read "There shall be a Nominating Committee consisting of the three Junior Past Presidents, senior member to be chairman, and those General Council members elected by the *Divisions* and Sections whose terms expire in the year in which the annual meeting is held." It was felt that the Divisions are a very important segment of the Society's activities and should be represented on the Nominating Committee.

Enrollment Statistics

An agreement between the U. S. Office of Education and the ASEE for the joint preparation of engineering enrollment statistics was reviewed by the Board, and it was voted to accept this agreement subject to amendments proposed by Treasurer Thompson and Vice President Saville.

Endorsement of Bill Before Congress

The Board passed a motion that the Secretary write to the Office of the Surgeon General indicating that the ASEE endorses in principle, insofar as it re-

lates to sanitary engineering, the Bill S.1453 which is now before the Senate.

Annual Meeting

The Secretary reported on the facilities for the annual meeting to be held at Rensselaer Polytechnic Institute. The local committee, headed by Professor Schmelzer, has done a very creditable job in making plans and preparations for the annual meeting. The facilities appear to be adequate to accommodate up to 2500 people. Emergency facilities could be utilized if the attendance should exceed this amount.

The Board recommended to the incoming officers that future annual meetings have only two general sessions and an annual banquet each year leaving the remaining time for conferences.

Journal

The Board voted that a page in the JOURNAL be set aside for use by the Divisions and Committees. A survey will be made to see which Divisions and Committees wish to utilize such a page, and a schedule will be set up for the use of this space.

The Board passed a motion authorizing space in the JOURNAL for a column to contain letters and comments which may be written to the Editor.

The Secretary pointed out that the cost of publication for the Yearbook for 1949 was $5400, representing a 46% increase over that of the preceding year. This is due both to the increase in printing costs and the enlargement of the Yearbook resulting from the increased Society membership. He pointed out that it might be possible in alternate years to publish only the geographical listing, institutional members, and officers of Councils, Divisions, Committees, Sections and Branches. This would effect a saving of approximately $4000, since it would eliminate the alphabetical listing which occupies most of the Yearbook.

Sections

A proposal to increase the dues of the Society and make corresponding rebates to the Sections was considered by the Executive Board. It was pointed out that most of the Sections hold only one meeting a year and the expenses are very nominal. These expenses are usually carried by the host institution. The Executive Board voted that while the Society wishes to cooperate with and encourage the Sections in every way possible, it does not seem advisable, with our limited secretarial staff, to set up a procedure for rebates to Sections.

Vice President Steinberg reported that at the Southeastern Section meeting an effort had been made to stress subjects of interest to younger members. Vice President Robertson will point out to other Sections that the problem of presenting programs which will interest younger men is extremely important and will ask the Section chairmen to emphasize this point in planning their programs for the coming year.

After discussion of the need for and great benefit which could be derived from a Section's manual, the Board voted to request the Committee on Sections to prepare copy for such a manual on the conduct and management of Section affairs for submission to the Board.

Summer Schools

The Board voted approval of the summer school in mechanical engineering to be held in 1949 at Rensselaer Polytechnic Institute.

Vice President Saville proposed a plan for canvassing the various Divisions and Committees of the Society to determine which ones would be interested in organizing Society sponsored summer schools. It was emphasized that the purpose of the summer schools is to serve as a teaching clinic to improve the quality of instruction in our engineering colleges.

Institutional Membership

The following applications for membership were approved:

Louisiana Polytechnic Institute—active institutional membership.

Cal-Aero Technical Institute—affiliate institutional membership.

Tennessee Eastman Corporation—associate institutional membership.

Respectfully submitted,
ARTHUR BRONWELL, *Secretary*

Memorial for Artle Joseph Lynn

Artle Joseph Lynn was born in Coryell County, Texas, on March 11, 1899. He received a degree in mathematics in 1928 from North Texas State Teachers College. In 1933 he received the M.A. degree from Texas Technological College and in 1948 he did graduate work in engineering at the University of Washington. He became a civilian instructor at Amarillo Army Air Field in 1942 and remained in this position until 1946, when he joined the faculty of Amarillo College. At the time of his death on February 27, 1949, he was head of the Mathematics and Engineering Departments. He was a member of the Texas State Teachers Association, the National Education Association, and the American Society for Engineering Education.

New Members

ABRAHAM, GEORGE, Training Officer, Naval Research Lab.; Part-time Instructor, University of Maryland, College Park, Md. H. H. Armsby, J. Hilsenrath.

BAKENHUS, R. E., Rear Admiral, U.S.N., Retired, Consulting Engineer, 75 West Street, New York, N. Y. C. J. Freund, A. B. Bronwell.

BARTELL, ERNEST C., Training Dept., Merck & Co., Rahway, New Jersey. C. J. Freund, A. B. Bronwell.

BATCHELLER, HILAND G., President, Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. C. J. Freund, A. B. Bronwell.

BAYER, BRUCE M., Assistant Professor of Mechanical Engineering, Vanderbilt University, Nashville, Tenn. W. H. Rowan, S. H. Acker.

BERGER, LOUIS, Associate Professor of Civil Engineering, Pennsylvania State College, State College, Pa. H. P. Hammond, B. A. Whisler.

BEST, STANLEY V., Assistant Professor of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. E. J. Kilcawley, A. B. Bronwell.

BISCHEL, KENNETH H., Instructor in Chemical Engineering, Kansas State College, Manhattan, Kan. W. H. Honstead, D. E. Braden.

BLAKESLEE, HORACE W., Instructor in Mechanical Engineering, Drexel Institute, Philadelphia, Pa. J. H. Billings, J. B. Baker.

BOGUSZ, EDWARD A., Instructor in Mechanical Engineering, The Cooper Union, New York, N. Y. W. Vopat, H. F. Roemmele.

BOURNS, CHARLES T., Professor of Agricultural Engineering, New Mexico College of A & M Arts, State College, New Mexico. M. A. Thomas, D. B. Jett.

BRASHEAR, ALVAN V., Asst. to Manager of Operations, Michigan Consolidated Gas Co., Detroit, Mich. C. J. Freund, A. B. Bronwell.

CARLSTONE, PAUL A., Staff Assistant, Education & Training Dept., Int. Harvester Co., Chicago, Ill. C. J. Freund, A. B. Bronwell.

Carlton, Ernest W., Professor of Civil Engineering, Missouri School of Mines, Rolla, Mo. R. Z. Williams, N. Hubbard.

CHUMLEY, JOSEPH G., Instructor in Mechanical Engineering, Louisiana Polytechnic Institute, Ruston, La. H. L. Henry, A. B. Bronwell.

COLGAN, ARTHUR R., Instructor in Electrical Engineering, South Dakota School of Mines, Rapid City, S. D. J. O. Kammerman, E. E. Clark.

COOPER, CHARLES M., Director, Engrg. Research Lab., E. I. du Pont de Nemours & Co., Wilmington, Del. A. P. Colburn, T. H. Chilton.

CORLEY, HOYT M., Assistant Director, Chemical Research, Armour & Co., Chicago, Ill. O. W. Eshbach, C. E. Watson.

CORY, WILLIAM L., Assistant Professor of Mechanics, University of Oklahoma, Norman, Okla. R. V. James, M. D. Creech.

COULTER, HERMAN, Employment Supervisor, Dayton Power & Light Co., Dayton, Ohio. C. J. Freund, A. B. Bronwell.

CRILLY, EUGENE R., Instructor in Economics, Stevens Institute, Hoboken, New Jersey. K. J. Moser, A. Lesser.

CURTIS, FRANCIS J., Vice President, Monsanto Chemical Co., St. Louis, Missouri. S. D. Kirkpatrick, T. K. Sherwood.

DANIELSON, DURWARD C., Instructor in Chemical Engineering, Kansas State College, Manhattan, Kan. W. H. Honstead, D. E. Braden.

DARBY, HARRY, Chairman of the Board, The Darby Corporation, Kansas City, Kansas. C. J. Freund, A. B. Bronwell.

DART, JACK C., Director, Research Dept., Houdry Process Corp., Moylan, Pa. C. J. Freund, J. D. Lindsay.

DAWIS, GEORGE G., Training Supervisor-Industrial Relations, Republic Steel Corp., Buffalo, N. Y. C. J. Freund, A. B. Bronwell.

DERBY, ELLES M., Manager, Management Education, Metropolitan Life Insurance Co., Ridgewood, N. J. C. J. Freund, A. B. Bronwell.

DORSEY, LEROY H., 509 South Wabash Avenue, Chicago 5, Illinois. C. J. Freund. A. B. Bronwell.

DUNCAN, JAMES M. Assistant Professor of Chemical Engineering, University of Florida, Gainesville, Fla. H. E. Schweyer, W. H. Beisler.

EASTMAN, FRED S., Professor of Aeronautical Engineering, University of Washington, Seattle, Washington. H. E. Wessman, E. D. Engel.

ESHELMAN, JOSEPH W., President, Eshelman & Co., Inc., Birmingham, Alabama. C. J. Freund, A. B. Bronwell.

FELBARTH, WAYNE, Instructor in Drawing, University of Detroit, Detroit, Michigan. H. C. Gudebski, C. G. Duncombe.

FERGUSON, SAMUEL A., Associate Professor of Electrical Engineering, University of South Carolina, Columbia, S. C. R. L. Sumwalt, C. R. McMillan.

FIELDS, RAYMOND I., Assistant Professor of Mathematics, University of Louisville, Louisville, Ky. H. H. Fenwick, W. B. Wendt.

FISCHER, KERMIT, President, Fischer & Porter Co., Hatboro, Pa. A. B. Bronwell, C. J. Freund.

FLYNN, WALTER W., Director, Engineering Dept., St. Martin's College, Olympia, Wash. F. B. Farquharson, R. G. Hennes.

GIBSON, JOHN O., Instructor in Engineering, Southwest Texas Junior College, Uvalde, Texas. W. E. Street, J. G. McGuire.

GILMOUR, KEITH W., Assistant, Electrical Engineering Dept., Rensselaer Polytechnic Institute, Troy, N. Y. C. H. Dunn, L. D. Runkle.

GOGLIA, GENNARO L., Instructor in Mechanical Engineering, Ohio State University, Columbus, Ohio. A. I. Brown, P. Bucher.

GOODHEART, CLARENCE F., Associated Professor of Electrical Engineering, Union College, Schenectady, N. Y. H. W. Bibber, C. H. Buchanan.

GOULD, M. IRWIN, Superintendent, Personnel Relations, Allied Chemical & Dye Corp., Buffalo, N. Y. C. J. Freund, A. B. Bronwell.

GRAY, HAROLD E., Assistant Professor of Agricultural Engineering, Cornell University, Ithaca, N. Y. O. C. French, G. R. Hanselman.

GRIGORIEFF, W. W., Director, Institute of Science & Technology, University of Arkansas, Fayetteville, Ark. G. F. Brannigan, R. G. Paddock.

GUIDON, MICHAEL, Instructor in Mechanical Engineering, University of Washington, Seattle, Wash. L. B. Cooper, J. B. Morrison.

HALL, GEORGE L., Instructor in Electrical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. S. B. Wiltse, F. M. Sebast.

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HAMMER, CHARLES F., Engineering Manager, Eng. Div., Westinghouse Air Brake Co., Wilmerding, Pa. C. J. Freund, A. B. Bronwell.

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Faculty and College Administrators	840
Industrial Administrators	92
Total New Members this year	932

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	U. of Pittsburgh	April 22 and 23, 1949	R. C. Gorham, University of Pittsburgh
Illinois-Indiana	University of Notre Dame	May 14, 1949	D. S. Clark, Purdue Univ.
Kansas-Nebraska	University of Nebraska		Linn Helander, Kansas State College
Michigan	Michigan State College	May 7, 1949	C. L. Brattin, Michigan State College
Middle Atlantic	U. S. Military Academy	May 14, 1949	R. T. Weil, Jr. Manhattan College
Missouri	Washington University	April 9, 1949	C. L. Wilson, Missouri School of Mines and Technology
National Capital Area	Johns Hopkins University	May 7, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Nov. 3, 4 and 5, 1949	C. J. Posey, State University of Iowa
Ohio	Ohio University	April 9, 1949	E. H. Gaylord, Ohio University
Pacific Northwest	Montana State College	June 16 and 17, 1949	E. W. Schilling, Montana State College
Pacific Southwest	University of California, Los Angeles	Dec. 28 and 29, 1948	Ralph Smith San Jose State College
Rocky Mountain	University of Denver	May, 1949	M. P. Capp, University of Denver
Southeastern	University of South Carolina	April 7, 8, and 9, 1949	J. E. Hannum, Alabama Polytechnic Institute
Southwestern	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University

Guide for Junior Engineers Available

A "Professional Guide for Junior Engineers," prepared by W. E. Wickenden and edited by G. Ross Henninger for the Engineer's Council for Professional Development, has been published and is now available. This includes chapters on: "The Engineer's Heritage"; "Transition from Engineering Student to Engineering Graduate"; "Some Important Decisions"; "Beginning Professional Practice"; "The Engineer and Registration"; "Trade or Profession"; "What is a Profession"; "Professional Relationships"; "The Second Mile"; a Reading List, and a Self-Appraisal Questionnaire. Written in Dr. Wickenden's inimitable style, this manual should be of great help to the student graduating from engineering college. The price is one dollar and copies may be obtained from E.C.P.D., Engineering Societies Building, 29 West 39th Street, New York 18, N. Y. Discounts are allowed in quantity lots.

Survey of Engineering Building Construction

A survey of building construction at engineering colleges, recently completed by the Engineering College Administrative Council of the Society, has shown that 51 state supported and privately endowed colleges completed construction on 23,143,000 cubic feet of buildings, totaling $18,770,000 in the four year period from January 1, 1945 to January 1, 1949. The survey of building construction authorized since January 1, 1945, showed that 59 engineering colleges had authorized 43,768,000 cubic feet of buildings, costing $53,969,000. It is interesting to note that the cost per cubic foot of completed construction was $.81, while that of authorized construction is $1.23. The compilation included space used for classrooms, research laboratories, instructional laboratories, and other facilities used for engineering instruction. Approximately 75% of the authorized funds were from federal, state, and municipal government sources, as contrasted with 25% from private donations.

Completed Since January 1, 1945

	Cubic Feet	Total Cost
Federal, State, and Municipal governments	15,023,885	$12,761,903
Private Funds	8,118,850	6,007,944
Totals	23,142,735	18,769,847

Authorized Since January 1, 1945

	Cubic Feet	Total Cost
Federal, State, and Municipal governments	31,865,612	$41,116,347
Private Funds	11,902,627	12,853,000
Totals	43,768,239	53,969,347

Other Wiley books on page 10

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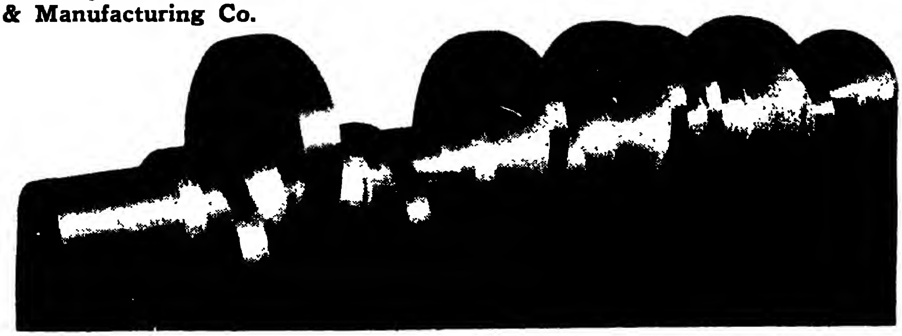

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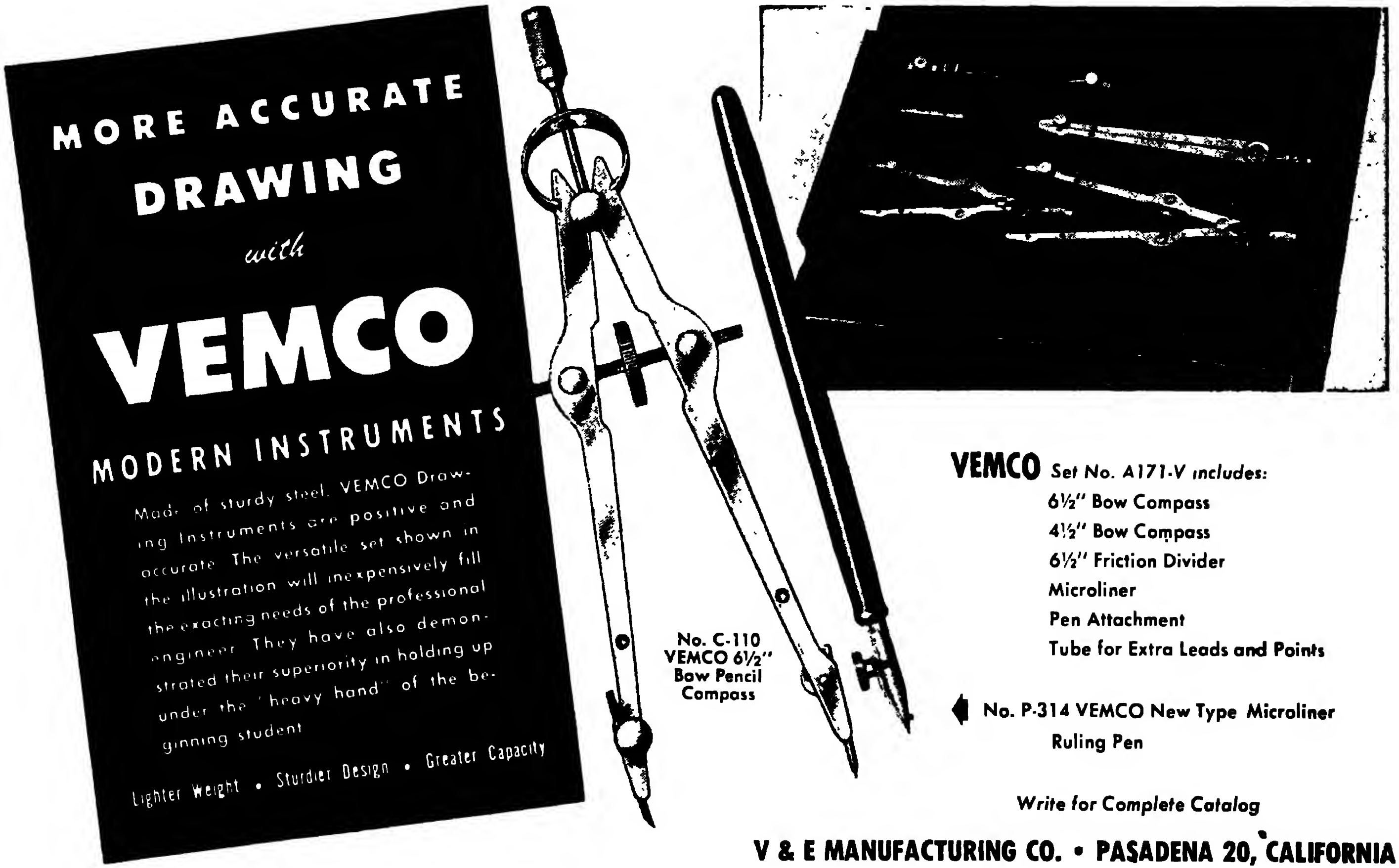
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Troy, N. Y.—June 20–24, 1949

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A "MUST" in Engineering Curricula

By EARLE B. NORRIS
Dean of Engineering, Virginia Polytechnic Institute

I find that we, upon whom falls the responsibility for outlining our engineering curricula, are prone to consider as "Musts" only certain subjects in the realms of mathematics and science as the foundation stones for our curricula. There is another basic course of study which is too often listed as elective or optional, but which I consider an essential foundation stone in the training of young engineers for service in American industry. I refer to the study of our American Economic System.

Whether the course which develops such an understanding is titled as a course in the History of Western Civilization, or is a course in the Principles of Economics, or both, seems immaterial so long as each embryo engineer is given a thorough understanding of how we got where we are, the working principles of our politico-economic system, and is able to draw sane, analytical comparisons between our American System and other political and economic ideologies.

American System

I like to call it the "American System," although it had its early roots in Europe, but was transplanted, nurtured, and now has obtained its fullest growth in America. Some call it the system of "free enterprise," which, to me, seems too much like the old days of "laissez faire," a painful period through which we passed on our way to our present full-flowering American System.

The System—
Where American industry, owned, managed and staffed by free men produced more for war in three years than all the rest of the world combined.

The System—
Which now is not only supplying the accumulated needs of our American people, but is pouring billions of dollars of American products into the economic rehabilitation of the rest of the world.

The System—
Which made it possible to absorb 12,000,000 veterans into American life with hardly a ripple of disturbance and which is now giving employment at higher wages to more people than were employed during the most active years of the war effort.

The System—
Which has been able to finance the training and education at Government expense of those millions of young men whose education was interrupted by war service.

The System—
Which supports a free public school system through the High School level and subsidizes collegiate education for those who aspire to it; which offers freedom of educational and vocational opportunity to all, regardless of caste, race, or circumstances of birth or antecedents.

"Free Enterprise"

"Free Enterprise" assumes that if a man has enough money he can engage in any business he chooses, and can run it to suit himself, pay any wages for which he can get men to work, hire or fire them at will, charge any price he can get, and

make as much money as the law of supply and demand will permit.

Today we have something quite different. Wage and Hour laws fix minimum wages and maximum hours; national labor laws control labor relations and provide for collective bargaining and restrict firing.

Of even greater significance is the role which Government is playing in the control of our economic system. Today any business man, whether a manufacturer, a retailer, or a farmer, no longer faces the greatest risk of a free enterprise system—the risk of uncontrolled ups and downs of our economy. Perhaps we have not wholly eliminated the business cycle, but we have so vast a network of government supports of prices, markets and credits that many economists believe that we will never have a repetition of the crash of 1929. It is generally conceded that these government measures prevented the postwar depression, so often prophesied, which was expected to throw 8 to 12 million out of work.

This modified system is far from the conception one gets from the term "free enterprise." Some now call it "safe enterprise." It is, however, strictly American. It is democratic in that it was created by democratic processes as a natural outgrowth of our cooperative efforts to promote the common welfare. It is not perfect, and needs some modification. Inflationary or deflationary trends need to be curbed and controlled. There is always the danger that one segment of our economy may seek by political pressure to gain advantage over other groups. To preserve and improve it we need sound, economic statesmanship, not politics, nor catering to political pressure groups.

Every embryo engineer is a potential leader in American enterprise. As such he should be capable of leading the thinking of other elements of our national life into sane channels, so that subversive ideologies may be subjected to the cold light of scientific scrutiny and analysis. False ideas can grow only in a soil of ignorance and misinformation. It is our duty to see that our engineering curricula give to every engineering student a thorough understanding of our American system, its shortcomings and its advantages in comparison with alien theories.

President Truman has recently said—"Education has been defined as a bulwark against the acids of fascism and communism. Neither of these totalitarian forms of government can survive examination by educated men and women—men and women free to search for the truth and imbued with the principles of liberty set forth in the preamble to the Constitution of the United States."

A Speculation on Civilian Applications of Military Instruction Practices

By ROBERT S. SHERWOOD
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Introduction

It is not the intent of this discussion to propose that successful methods of military instruction be transplanted into civilian teaching practice. However, it is desirable to see whether any of the military practices hold possible value to those of us in civilian education. A few contrasting practices may be cited as reason for being sure that we aren't overlooking a few possibilities.

In good military instruction, the teacher was trained to be a military teacher; in our profession, a teacher is not normally required to have any formal training in teaching techniques. In the military, instruction was supervised to the extent of having periodic classroom visitations; in our practice, it is very rare for visitation to be made for the purpose of observing standards of instruction. Proper military instruction required a careful study of best methods to use in the classroom presentation; we seem to acknowledge lecture, recitation, and laboratory as our main methods. Training aids of many forms were widely used in military instruction, but we don't often have time to use them or we find our frequently used aid, the classroom blackboard, is in such bad shape as to be long overdue for repair. The military invited and received constructive suggestions for improvement of instruction from its students. We seem to feel the same student, now in civilian clothes, is not capable of a valid judgment of the effectiveness of our teaching.

These variances of practice do not necessarily suggest that only one practice is correct. However, it is the writer's opinion that it is advantageous to study some of these differences in more detail.

Preparing an Instructor to Teach

It appears that there are two main qualifications necessary in any successful teacher—knowledge of the subject and ability to disseminate that knowledge properly. Of the two qualifications, we do more about the former, than the latter. In employment of college teachers one wonders if sufficient attention is given to whether or not a man can teach. Surely an awful lot is left to chance when not even an interview is required. It seems inconsistent for a teacher in a public school system to have to take work in teaching methods while we college teachers are immune.

It is recognized that development of adequate knowledge to teach a military subject usually requires much less time than in becoming thoroughly acquainted with the subject of thermodynamics, for instance. Therefore, in a given length of time in which to completely train either type of teacher, the military instructor will usually have far more time in which to learn effective presentation of his knowledge. It is the writer's opinion that this is one of the major factors that makes a college teacher lag in putting up a first-rate performance. Few colleges can afford the luxury of a rehearsal of every first presentation of a lesson by a

new teacher as was usual in the case of a military teacher at a service school. The idea of rehearsing a lesson or part of it is certainly not new. However, the practice of requiring an instructor to rehearse every first presentation of a lesson, no matter how experienced he may be, is certainly conducive to a more finished job. This also sheds more light on how far the military went to insure a successful job of teaching.

There are several concrete steps which can help a college teacher improve his "teaching ability." He may understudy a man who is acknowledged to be a superior teacher. He may have a colleague and trusted friend monitor his presentation for constructive suggestions. He may have a portion of his lecture or conference transcribed for a play-back. In connection with this latter point, anyone who has never heard himself as others hear him is in for a distinct surprise. You may well think someone has played a trick on you. He may take appropriate education courses. All these steps may frequently be taken by an individual on his own initiative and that is certainly commendable. For a teacher whose primary function is teaching, improvement may be expected if he knows he is judged and promoted on his ability to teach.

Supervision of Instruction

It was customary in military instruction at service schools to find a great deal of time being spent in supervising classroom instruction. Sometimes too much time was spent at this; the individual instructor never felt wholly reconciled to having someone sitting in on his class for the purpose of checking on him. This was particularly true if the supervisor was not a competent judge.

At the Engineer School during the war, the assistant commandant required that a manuscript be prepared and be approved for every lesson given. This amounted to several thousand manuscripts, and you may correctly judge it was a terrific amount of work. The manuscripts were supposed to represent what was to be covered in that class. Any omission of a point was considered a breach of your duty as a teacher. This was a definite restriction and in academic circles would have been a breach of fundamental rights of a teacher. On the other side of the ledger, these manuscripts and the resulting supervision of course content brought out the fact that some instructors were teaching outmoded material, some of which was in error. It forced many instructors to get busy and revise their notes. Aside from this, these manuscripts were a great help to a new instructor in preparing himself.

In civil practice we frequently find several teachers in the same course have different but favorite interests which lead them to dwell on those interests to the exclusion of other material listed in the course lesson assignment plan. This is natural. However, it does seem that in a basic college engineering course where several teachers are used, the students should come out with some uniformity of minimum knowledge on a previously agreed upon number of subjects. Otherwise we find ourselves having to backtrack in courses for which the basic course is prerequisite.

In college teaching, it appears to the writer that overall improvement of instruction would result if optimum, but increased supervision were exercised by at least those in charge of sections of a teaching department. It is just human nature to make your best effort if you know you are to be judged by someone you feel is competent to judge. However, if competent judges of a teaching performance in a certain subject are not available, then a program of supervision will not be effective and should not be undertaken; indeed to do so would cause tremendous friction and down-right trouble. Even if competent judges of a teaching performance are available, it wouldn't be desirable to institute a program of supervision of a teacher unless he voluntarily seeks such assistance. On the other hand, if a program of supervision is honest in purpose and tactfully

operated by thoroughly competent people, why wouldn't it work in a college?

Use of Training Aids

The list of devices, equipment, and paraphernalia that can be classed as a training aid is extensive, to say the least. In teaching mechanical engineers, there seems to have been a time when a larger number of training aids were used than is now common. Remains of old models, cutaways, slides, and charts are to be found stored away in odd places. The decline in use of these devices for teaching college engineers seems to parallel the de-emphasis of practical type work in favor of the more rigorous course in fundamentals. Also it seems that rigorously presented courses in engineering fundamentals do not require as extensive use of training aids to be effective. However, a person may wonder if the perfectly human trait of "going from one extreme to another" has not been shown.

Possibly the engineering teacher feels that in a one-hour lecture period he can't afford the time consumed by using training aids. This feeling may exist because we don't really understand the breadth of the field of training aids or the simplicity of many effective aids.

Because of the attention given visual aids, motion pictures in particular, we probably have minimized the usefulness of the many simple and less time-consuming aids. Charts, models, slides, sketches, texts, notes, blackboards, comfortable lighting and seating are all teaching aids in the broad sense. If a teacher would spend the time to experiment with use of a few of the aids, he would be surprised how easily and effectively they can be fitted into a one-hour lecture period.

A concrete example may be cited of use of a chart to present the data, operating characteristics, and requirement for a problem in wire rope selection in a machine design course. This particular chart, about 3′ × 4′, has a scale drawing of a rotary oil well drilling rig showing by use of ballooned photographs the component machines in the rig as well as the reeving diagram for the rope. When the problem has been presented with the aid of this chart, the students seem more interested in learning how to do the job. They can more easily visualize the effect of operating conditions on the choice of a factor of safety, for example.

Motion Pictures and Slides

Motion pictures, strip films and slides are important visual or audio visual teaching aids. Great attention was devoted to their use in military instruction. We in the civil teaching field do not always realize their most effective use. If a film is shown to students without adequate orientation, their reaction may be characterized by a "Swell, now we don't have to do anything" attitude. Such an attitude discredits the value of the film prior to its showing. Most effective use of films as a teaching aid requires a thorough discussion of what is to be shown, why, what to look for, and if possible a quiz should follow covering important points of the film. The effect upon the student is pronounced. A film used as a teaching aid should be as carefully selected as any other material used in a course. To show a film to a group of students without the teacher having previewed it is a mark of insufficient preparation. Surprisingly enough, this does happen.

One item not discussed so far has a profound influence on the relative lack of use of training aids as contrasted with the copious use made of them by the military. This factor is largely availability of training aids or availability of facilities in which to make them. A college teacher is not intended to be a craftsman to the extent of building models, inking charts, taking pictures, or doing any of the other tasks incidental to transforming an idea into a usable teaching aid. On the other hand, rather limited facilities and money are available for this purpose. So long as this exists,

use of training aids will never reach the level that might be desirable. It might be shown that the cost cannot be justified by the average institution. That is a problem beyond the control of the teacher. Certainly, it is a problem to be attacked by those men whose responsibility it is to see that instruction is improved.

Conclusions

This paper has discussed only three of the many phases of instruction in which there is pronounced variation in practice between first-class military and civil instruction. If we assume the majority of college teachers are technically qualified to teach, any increase in effectiveness of our teaching will result largely from improvement of the instructor's ability to teach, or disseminate his knowledge of the subject.

It is the writer's opinion that distinct improvement in college teaching can come by increased efforts along the following lines:

1. Give the teacher who needs it an opportunity to learn effective teaching techniques.
2. In order to get valid suggestions for improvement of ability to teach, a minimum amount of diplomatically accomplished supervision by an outstanding teacher would help if the individual teacher being monitored had asked for the assistance.
3. If the necessary money could be provided to buy or produce teaching aids in a liberal quantity, an increased interest in their classroom use would show up in the teacher. This would undoubtedly lead to a more effective classroom presentation.
4. Probably the most effective stimulant for improvement of college teaching would be an honest recognition by administrative personnel that providing good teaching is in many cases the prime responsibility of the teacher. With such a placing of emphasis, the teacher should be judged and promoted primarily on his ability to teach.

In the News

The Senate Committee on Expenditures in the Executive Departments has reported out S. 1809 and the bill is now on the Senate calendar.

This bill, if enacted, would establish a permanent and continuing donation program of surplus property to "tax-supported and non-profit school systems, schools, colleges and universities which have been held exempt from taxation under Section 101 of the Internal Revenue Code." The bill provides for donation both through State Departments of Education and directly to the institutions.

The donation would include surplus not only from the armed services but *also from any and all agencies of government.* It would be available to schools and colleges without cost other than that of care and handling. The Federal Security Agency, which, in effect, implies the U. S. Office of Education, would have the responsibility for certification of the usability of surplus for education and the need of the institution.

The significance of this legislation to educational institutions is obvious. Institutions have received valuable surplus but if a comparable bill had been in effect in 1945 much additional surplus property that was diverted to other channels would have been available for educational use.

If you concur in the importance of this proposed legislation to your institution, you may wish to write your Senators requesting them to support the bill—S. 1809.

Science Teachers Teach Professional Attributes*

By N. W. DOUGHERTY
Dean of Engineering, University of Tennessee

The Committee on Professional Recognition of ECPD has published a list [1] of attributes of a profession and a professional practitioner. Our study of the relation of science to the teaching of professional qualities will be based on this list which may be condensed as follows: satisfaction of a social need, use of discretion and judgment, and intellectual activity, group consciousness, and legal status. For the practitioner the qualities may be stated as: a service motive, ethics or a code of conduct, a relation of confidence, and group responsibility. Other qualities may be added but when they are added they will probably be subject to the same treatment and to the same analogies.

We will undertake to show how students of the professions may be made aware of their duties, obligations and responsibilities as professionals by the study of science and applied science. Of course the teachers must be aware of these possibilities to prevent the tendency to compartmentalize which is too common in American education today. Students, and teachers, often know a physical law as defined in the physics book but it is a total stranger when they meet it in mechanics or thermodynamics because the language has been slightly changed. So also is this true with laws of science when carried over into the fields of ethics or human relations.

Some time ago I pointed to certain contributions of science and technology to education.[2] They are real and quite obvious in an age where practically the whole population knows something about the results of science and a large fraction of the population has made study of the elements of science. Modern living has been paced by the automobile, the movie and the chain store, and these have been made possible because it is an age of science; they are the children of science.

Professional consciousness has developed contemporaneously with the growth of science. Wherever there has been a knowledge of science there has been a professional attitude and a professional spirit. The first code of professional ethics was written by a leader in the medical field back in the "golden age of Greece." We naturally expect common attributes in children of the same parentage and products of the same age. Science, therefore, has qualities which can be carried over into all the professions. We have already suggested certain attributes of a profession; now we shall undertake to show how some of these may be developed by a good science teacher.

Unless we take thought we are not apt to note the relation between ethics and scientific principles. We remember the common saying, he that is guilty of the least is guilty of the whole, but we do not always realize the unity in all law. Ethics we consider as the ideal of human action or human relations and often think they are theoretical rather than practical and based on the fundamental laws of conduct. Yet an understanding of the laws of nature, the relations between natural

* Presented at the conference on Professional Development at the Annual Meeting, Austin, Texas, June 16, 1948.

[1] ECPD thirteenth annual report, 1945, page 29.

[2] JOURNAL OF ENGINEERING EDUCATION, November, 1947, page 187.

forces and processes will give us a basis for understanding the finer laws of human relations. We know the laws of nature are true and unchangeable and to violate a law means punishment as surely as cause is followed by effect. In ethics and human relations we hope that our violation will be the exception and the consequence will be averted. Our ethics even teach us to forgive and not to mete out just punishment under certain circumstances.

Let us take the code of ethics of a professional practitioner and see if we can understand its canons better if we know some of the principles of science. The code will state the relation between the practitioner and the public, the relation of the practitioner and other practitioners, the relation of the practitioner and his client and in some cases the relation of the practitioner and his employees. These are based on fair dealing, truthfulness, consideration, kindliness, modesty, and an understanding heart.

In general we might believe that science does not contribute much to kindliness and consideration but when we consider that these are children of truthfulness and understanding we begin to see the relation "Duty is the stern daughter of the gods" sayeth the poet; science is law sayeth the student. Law, yes inflexible law, but to be law it must be truth and truth is neither harsh nor kindly; it is but a statement of relations known to exist. Under some circumstances, stating the truth may injure the feelings but under other circumstances stating the truth may mean freedom and happiness. The student of science will be imbued with the necessity for truth and an abhorrence for falsehood; these are the fundamentals of any code of ethics.

Another quality fostered by the study of science is humility. Before the infinite combinations of nature, the magnitude of its architecture and the precision of its laws, any normal human will feel the necessity for humility. Human knowledge, human actions, human power are very finite in comparison yet the powers of the imagination allow men to claim kinship to all that men can comprehend. Human relations are built on a smaller scale and, although they deal with imponderables, they follow laws both physical and emotional and the understanding of these laws will aid in understanding the more intricate human relations. The teacher of science may well point to the laws of human conduct as he aids his students in understanding the laws of attraction and repulsion or the laws of dynamics and statics.

One of the most distinguishing characteristics of the professional practitioner is his relation of confidence. He has knowledge and skill which are not possessed by his client or his public and this forces them to depend upon the practitioner's judgments. Professionals and professionals alone can determine whether a professional act has been correctly performed. The professional must protect the life, the rights, the welfare, the spiritual well-being, and the property of his client. The very nature of his knowledge and skill requires him to accept this responsibility. Only an understanding person can afford to accept such burdens.

Scientists must have the same qualities. They cannot cry wolf! wolf! neither can they put their heads in the sand. The study of science will give them knowledge and all know that knowledge is power. Knowledge of scientific laws will give understanding of nature's laws and will give a method of checking understandings of other laws. Certainly we in this generation will require of the scientist that he observe the relation of confidence that we impose on his fellow professionals.

Another important characteristic is judgment or the exercise of the choice of alternatives. This is an essential characteristic of all professionals and all scientists. Science checks and double checks. It has a technique for determining the correctness of a solution. It begets confidence because of its experience and its methods, these beget a willingness to take

responsibility and furnish a basis for forming judgment. First the facts, then the conclusions from the facts.

Professionals perform mental activities rather than exercise manual skills. Their judgments, their solutions, and their advices are the result of the application of their special knowledge and skill to accepted situations. All science depends upon mental valuations of physical and emotional observations. Professional judgments and scientific judgments are performed after the same manner. They are one and the same process applied to varying situations.

Professionals are a group of cooperative workers rather than a number of lone workers. We can hardly think of a profession which contains only one practitioner. They build upon the experience of all similar workers of the past, they exchange ideas and methods of the day and depend upon each other for joint solutions of difficult or new problems. They organize into societies for the exchange of knowledge and experience and they meet from time to time for the stimulation of contact with each other. This is essential to professionalism.

Paralleling in almost every detail is the necessity for cooperation among scientists. They cannot individually initiate all the necessary ideas for scientific solutions; they too must build on the past and they need the inspiration of communion with kindred minds. To do these things as scientists is but to follow the same path traveled by the members of the profession.

Integrity is essential to success; it is the foundation and the capstone of a professional career. Diplomats may seem to thrive by ignoring its demands but the day soon comes when the record has to be published and the people brought up to date. With professionals the necessity is ever before them; they must daily make decisions which must be in accord with the best interest of their clients or the public, and double dealing is out. We have already spoken of the relation of confidence and the necessity for professionals to determine the excellence of their own work. No one dare assume these relations unless he be basically honest.

In science there is constant reminder that laws cannot be ignored. Build a bridge or a machine from shoddy materials or with poor workmanship and disaster will be immediate. Mix the wrong chemicals and the explosion does not wait for a check of the labels. Scientists must know the truth and always observe it lest they commit some grievous fault. Fidelity to the truth is basic training in honesty and builds an attitude of mind known as integrity.

Certain great laws in science have their counterpart in professional life. The laws of action and reaction, the law of conservation of energy, the law of the unity and harmony of all knowledge, have their places in professional life. In the practice of engineering these are part of the technical equipment of the practitioner but they have further application in the practice of his profession. Similar, if not the same laws, apply to human relations as well as to physical relations and the use of energy.

Ye know that a little leaven leaveneth the whole mass. Give and it shall be given unto you and in good measure. These are action and reaction in human relations, they are the grist of the mill which grinds out professional success. We have already mentioned integrity; now we will introduce its kinsmen, a clear mind and a pure heart. These come of conservation of energy and talent; they are blighted by frivolity and waste of the nervous store. Some day when we know human actions better, we will be able to point to almost identical relations in human activity with those which we have discovered in the physical world about us.

We have said that professionals need to exchange ideas to get inspiration to go farther in the way. We think of science as cold hard facts rather than something which will appeal to the emotions. This is true, but there is the urge to go farther, to climb higher, and to search for

more knowledge; these are qualities needed by professional practitioners.

Does science serve an indispensable social need? This has always been true of professionals but the world had a long history before the scientists came to professional stature. For the professional each case must be handled as if it were the only and last case and the whole record depended upon it. To the scientist a truth was true in the beginning, 'tis true now and ever will be. He is dealing with absolutes and they cannot change. Much that he does may not have a direct social application but he may rest assured that the day will come when any truth that he may discover will be essential to some social activity.

Usually we think of the professions as requiring legal status with formal standards of admission. Science knows no laws except the laws deduced from observations and known facts but scientists too must observe the laws of health and safety which are the basis of legal recognition of engineering professionals.

By this time you have discovered that I am a bit of an optimist, that I have drawn parallels which may not always exist, but I am sure that you will agree that there are many analogies in the teaching of science and in recognition of responsibilities by professionals. Being a professional is similar to growing in other realms of human living: "First the blade, then the ear, then the full corn in the ear." For science it is first the germ, then the embryo, then the full grown living thing. By noting these and other analogies, the teacher of science will aid in developing professional attributes and professional attitudes in his students.

Sections and Branches

The annual meeting of the **Southeastern Section** was held at the University of South Carolina on April 7 to 9, 1949. The meetings on the first day were devoted to the Research Branch and included talks by Norman Smith, President of the University of South Carolina; Mayor Frank Owens, of Columbia; Sam Tour, President, Sam Tour Company; R. S. Poor, Oak Ridge Institute for Nuclear Studies; and John C. Green, Department of Commerce. At a luncheon meeting, J. W. Barker, President, Research Corporation, spoke on the program of his organization.

In the afternoon session, the research theme was continued with talks by J. M. Dalla Valle, E. M. Schoenborn, Jr., and E. Donald Kennedy. At the evening banquet, James S. Thomas spoke on "Research, Culture and the Dinner Bell."

The second day sessions included talks by Governor Thurmond of South Carolina; Dean Weil of Florida; W. W. Rankin and Edward Kraybill of Duke University. At the luncheon, F. C. Smith, Editor, *Southern Power and Industry*, spoke, and at the evening session, Dean Steinberg discussed his recent trip through Latin America.

A breakfast session on the third day featured Dean Dougherty on the Buck Hill Falls Conference. This was followed by talks by Dean Lampe of North Carolina, L. W. Bishop, and H. H. Armsby. Newly elected officers included: H. Gale Haynes, Chairman; E. B. Norris, Vice Chairman; R. L. Sumwalt, Secretary-Treasurer; and F. J. Lewis, Representative on the Council.

Four Year vs. Five Year Engineering Curricula*

By WILBERT J. HUFF *

Chairman, Department of Chemical Engineering, University of Maryland

The rapid pace of industrial diversification, the proliferation of the sciences, the increasing appreciation of the economic and social advantages accruing from the application of new scientific knowledge under engineering philosophies to multitudinous tasks of modern peace and National defense bring to the thoughtful engineering educator an almost despairing realization of the limitations of a four year engineering curriculum, be it ever so well chosen, staffed, and equipped. To assuage to some degree, at least, this need, five year engineering curricula are in effect in some of our institutions.

Pressure for such five year courses is particularly heavy in chemical engineering, the speaker's own field, because of the extended laboratory work in both the chemical and physical phases of the field. The American Institute of Chemical Engineers as of May 22, 1947 lists 73 institutions offering degree work in Chemical Engineering, with 8 of these indicating that they offer curricula leading to the bachelor's degree requiring 5 years. Of these 8 institutions, one states that the curriculum may be completed in 4 years instead of 5 if the pre-engineering work in college is covered in 2 years instead of 3, and 4 others involve cooperative programs in which students alternate between classroom and industry. Of the 3 remaining, one was listed as having been initiated within the year preceding the date of issuance of the list. One 4 year institution includes 1 or 2 summer sessions but will not be specially considered.

An analysis suggests that the cooperative programs be differentiated from the the other 5 year programs. Including these, the 5 year curricula represent 11 per cent of the list; excluding these, only 5½ per cent with only a little over 4 per cent unequivocally listed as normal 5 year curricula.

Passing, for a time at least, the need for and opportunities afforded by the 5 year curricula, let us inquire into some of the motivations in play in an endeavor to account for the present small number of 5 year curricula.

Unquestionably a very powerful influence is social, particularly family relationships. Most students of undergraduate age or younger will normally have developed associations that will affect their plans for family life. Those who have attended or served in coeducational institutions will agree, perhaps, that Betty Co-ed usually feels that, no matter how brilliant her scholastic record is, she has failed in an important subject if she does not acquire an engagement ring by the time she has gained her degree. The delay after her graduation, while the young man is establishing a sufficient economic competence for marriage, may and often does major damage, and such unduly long frustration has been recognized as a serious problem. This is not diminished by the adoption of five year curricula for the men, while maintaining companionate four year courses for the women.

The golden flood of GI dollars has brought a temporary solution to this

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problem, but this flood will soon have passed its crest. The financial burden will again revert to the parent and here too we have powerful motivation in favor of the four year over the five year curriculum. The possession of an engineering degree is a recognized economic aid that appeals to practical minded families from whom engineering students are generally drawn, and the ever present possibility of a major decrease in family income weighs heavily in favor of the four year course. With high taxation and important reduction in living standards due to inflation, there is now apparently little hope for a general affluence favoring the five year curricula.

A third important influence is a prevalent attitude among industrial executives favoring the early recruitment of most of their cadet engineers with a corresponding unwillingness to compensate adequately for the investment in time and money for studies beyond the conventional four years. Even though the organization is research minded, and is willing to maintain a research division and corresponding staff, for its routine engneering tasks it usually prefers to equip its subordinate engineering aides by specialized industrial training and experience after the four year course. A president of a large chemical engineering operating and construction company once expressed the following sentiments to a member of his staff who was resigning to accept the chairmanship of an engineering department at a well known university: "Remember to impress upon your university staff members and your students that we in industry need chiefly men who know our business and can reason simply and clearly, resolving our problems into their fundamental elements in an approach that we all can recognize. The important decisions are simple ones. It is true that we need a few highly educated specialists but we need relatively only a few of these."

It is due to the support of industrial executives who wish young recruits that we owe the rise of the 2 year technologic institutes.

The foregoing motivating influences, namely (1) The desire to found a family early in life. (2) The limitations of the parental support and (3) The desire of industry to begin specialization in individual technologies at an early age, form the basis of an effective distinction between the industrial cooperative curricula and the standard undergraduate curricula. These cooperative courses give the student a measure of economic self-support much earlier than is ordinarily possible in the standard curricula. In cooperative circles the extension of the program to five years therefore does not meet the same resistance that is encountered in the normal situation.

A further resistance favoring the four year curriculum may be denominated "conservatism" or perhaps "traditionalism." The four undergraduate years have been deeply embedded in thought and custom. Even tellers of entertaining tales of undergraduate life at times weave four year class customs and distinctions into their narratives to give the pattern of authenticity, and the fond parents begin the baby's savings with the budget of the four year college course in prospect. It is this traditionalism, in the writer's opinion, that prevented any sizable realization of the Goodnow plan at Johns Hopkins. You will recall that President Frank J. Goodnow, stressing the importance of creative scholarship through graduate study, sought to encourage such study by eliminating the undergraduate degree as a requirement for admission. He proposed that the pre-graduate preparation be shortened by the adoption of a program that would permit the competent fourth year student to enter the graduate school without a bachelor's degree, thus requiring only 6 instead of 7 years from high school graduation to the Doctor of Philosophy degree.

Your speaker served as a member of the governing board of the Johns Hopkins graduate school for many years prior and subsequent to the adoption of the

Goodnow plan by that institution. So far as he could determine, only relatively few students chose the Goodnow plan, and some of these at least were motivated by unusual circumstances. Educationally and socially there is much that appeals in this plan, but the economic value of a bachelor's degree where the continuity of residence is broken coupled with traditionalism appear to have prevented any widespread acceptance.

So far this discussion has avoided an evaluation of the comparative merits of the two curricula. All of us perhaps will agree that the student will contribute more if he has had the benefit of a five year instead of a four year engineering education. In chemical engineering, the speaker finds that the four year undergraduate curriculum under his supervision might well be expanded by more formal courses as in precision of measurement, structures, design, business administration, additional laboratory work in qualitative inorganic analysis and organic chemistry, and in the exercise of independent investigation. Such topics might make a very profitable fifth year. Moreover, much of this work will move more rapidly if it follows present studies without too great a lapse of time. Educationally, then, a case appears to be established for the five year curriculum. Because of the powerful resistances against such curricula, however, it is very doubtful if there will be widespread acceptance of these so long as our present general educational system prevails. In most institutions the scholastic development of the student in the fifth year is the task of the graduate school and it is probably only just to make our comparison on the basis of (1) the five year engineering curriculum versus (2) the four year engineering curriculum terminating in a bachelor's degree followed by a fifth year in the graduate school, terminating possibly in a master's degree.

Both programs seek to accomplish the same objectives. Broadly they seek to impart a knowledge of the sciences basic to engineering, together with a grasp of technologies sufficient to make the graduate immediately productive in an engineering organization. A third and paramount objective, in view of the constantly developing nature of all knowledge, and particularly the rapid advance of modern science and industry should be the stimulation and development of the creative faculties. This is achieved when the graduate may in his subsequent career enter, master, and advance new scientific and technologic fields and bring these to the solution of new engineering problems, even to the creation of new industries.

If the education of the student has attained the last objective, the others will be added to him. May we let this then be a primary standard of measurement as we compare the merits of the two programs. Your speaker is of the opinion that we must. How often in practice do we find the engineer educated in one field practicing in another? In one engineering school that came under his observation every chairman of a major department had received his formal education in a field other than the one he headed. At least two of these attained the presidencies of the respective National engineering organization in the fields in which they taught and all attained National recognition in their fields. Somewhere in their formal educational or professional experience they must have acquired the disciplines and perspectives that underlie creative scholarship and the art of self education.

This task is preeminently the function of the graduate school where the maximum of scholastic self-discipline, responsibility, election, specialization, and deductive reasoning should develop and the research techniques should flourish. Ordinarily, too, these graduate years are made possible by economic support usually not primarily from the student's family but rather from his own labors and as a reward for his own distinctive scholastic attainments. The effect of this support upon his interest and application is most wholesome. Frequently, too, the

graduate years come after a period of engineering experience in industry, bringing a maturity and an appreciation not to be expected if the fifth year follows immediately after the fourth.

A further commendable feature in the four year undergraduate-one year graduate combination is the elimination of class distinctions. Thus the student whose economic need requires him to drop out for a while is not embarrassed when he returns.

In summarizing, your speaker favors the maintenance of the four year curricula plus graduate work as preferable educationally as well as more feasible socially, economically and traditionally.

No educational program however long can or should hope to solve in advance all of the problems the engineer may encounter. At the best it teaches the engineering student to educate himself. In the endeavor to accomplish this as effectively as possible, the following are suggested in conclusion:

(1) Use every proper influence to make pre-engineering instruction more effective. Much of the present collegiate instruction in the humanities, for example, should be anticipated by sound programs in the preparatory and high schools.
(2) Extra-curricular activities and undergraduate life should be organized to develop qualities essential to social intercourse and leadership.
(3) With the freedom made possible by (1) and (2) use the all too short years allotted to engineering instruction for that purpose.
(4) Cooperate actively with philanthropic, industrial, commercial, and governmental interests in the establishment of research funds for the encouragement of graduate study and investigation.

Perhaps these will take away some of the pressure for the expansion of engineering curricula from four years to five years.

Sections and Branches

The **National Capitol Area Section** of the A.S.E.E. held a regional meeting at Johns Hopkins University on May 7, 1949. The Chairman was H. H. Armsby, and the program included greetings from W. B. Kouwenhoven, Dean at Johns Hopkins.

R. Morgan, G. F. Corcoran and J. E. Younger spoke on "Technical Courses Offered for Government Employees by the University of Maryland." Other papers given included "The Evening Courses of Study in Engineering Offered at the George Washington University" by C. H. Walter; "New Engineering Facilities at Howard University" by L. K. Downing; "Research Cooperation Between Universities and Government" by L. Hafstad, R. Gibson and R. D. Fowler; and "Civil Service Commission Efforts to Obtain Cooperation Between Federal Agencies and the Universities" by E. J. Stocking.

The **Middle Atlantic Section** of the A.S.E.E. held its Spring Meeting at the United States Military Academy on May 14, 1949. Col. B. W. Bartlett presented a paper on the "Mission, Curriculum and Teaching of the United States Military Academy." Another paper presented was "Special Weapons Project on Education for Nuclear Engineering" by Maj. General K. D. Nichols. This paper was discussed by E. Weber and I. P. Orens.

American Destiny and Engineering Motivation*

By ALBERT E. AVEY

Chairman, Department of Philosophy, Ohio State University

Our topic, "American Destiny and Engineering Motivation," means to raise the question where American civilization is now headed, without attempting to predict the direction it is going, but rather to acknowledge that there are alternatives, especially two major alternatives. It may go on contributing to the fuller realization of American life and to human perfection. It may end in self-destruction, and in obstruction to the advancement of all humanity.

What motivations are needed to make science in applied form an effective factor for good if headed the right way?

In the first place, I want to maintain the human value of comprehensive thinking. A few years ago, Professor Cassius Keyser, of Columbia University, published a book, "The Human Value of Rigorous Thinking." With that thought I presume we all agree, but I want to change the adjective, gain a different perspective on the problem, and make it "comprehensive"; not giving up the "rigorous," but adding "comprehensive."

In this day and age, we are accustomed to emphasize facts and data. This is inevitable. Unless we bring our hypotheses, our theories, our view of things down to embodiment in details, we are not sure they are rooted in the actual, and certainly we want to have our view real so far as we can make it so. But it is also true that facts and data alone do not give us science. There are certain details of experience which have been known to humanity down through the centuries from ancient to modern times, and yet not all these data constituted *science* as we know it now. In addition to facts and data there have to be judgments about the collection of things. But I want to suggest that even this is not enough. There is a third step necessary for complete interpretation of experience and that is constituted by judgments upon our previous judgments. We have thus at least three important levels of experience: facts, judgments about these facts, and then judgments about these judgments. This is what we mean by the critical attitude that we take and must take toward the attainment of any advance in the development of human knowledge.

Science and Philosophy

This statement will recall to our minds a formulation made in the last century. Herbert Spencer wrote about common sense, science and philosophy. "Common sense," he said, "is relatively unorganized knowledge. The sciences are data of experience organized about certain particular points of view chosen by the interest of the thinker; and then we must raise the question as to the interrelation of the special sciences and so come to the task of philosophy."

This suggests a still further thought which comes from a longer way back, from one of the discussions of Plato, who suggested that it is not enough merely to add more and more data. But in addition to this, Plato suggested, it is a necessary thing to be critical of our presuppositions. Let us ask: What are we taking for granted in making our judgments, in getting our data, and so in

* Presented at the Annual Meeting, Minneapolis, June 18–21, 1947.

formulating our science? Is it possible to come to some suppositions that the human mind inevitably makes? This process of going beyond the data in steps of criticism is not merely a philosopher's concern. I find it in the *Scientific Monthly* for June, 1947. There are not only articles upon the exploration of the upper atmosphere by means of rockets; not only an article on the future of the science of animal breeding; but I find an article with the title: "A Layman Looks at Science" by James L. Chambliss. There is an article, "The Problem of Plan and Purpose in Nature," by G. G. Simpson. A third is headed, "The Scope of Science," by R. W. Gerard.

Another reason for dealing with the problem we have before us lies in the suggestion given by an eminent teacher of chemistry a few years ago in talking to a group of honor freshmen. Said he: "The fact that we have knowledge does not determine the use to which that knowledge will be put." Something else has to come in then, to decide what direction the knowledge will take. It reminds us of the classic scene in the dialogue of Plato, the Phaedo. Socrates is approaching the hour of his death, sitting on the edge of his couch rubbing his leg, and talking about how he happened to be there. Some people said he was there because he had certain bones and muscles that brought him to that position; but his contention was that what really brought him was the fact that he had certain ideals and aims for which he stood and for which he was willing to die.

In all of this, what I mean to suggest is fundamentally the enlarging grasp of meaning which is necessary for the solution of some of the humanly interesting problems that keep coming to all of us, including scientists; and with these we must reckon.

Overlapping Areas

My second point is this: If you go to the limit implied in this process of increasing the scope of human thought, you will inevitably come to some fields which have not in the past been included in the interest of science, applied or pure, so-called. You will come to those fields which have been included among religious and philosophic interests. Of course, your agreement or disagreement with this statement depends on what you conceive to be the nature of religion; and your conception is important here. It revives an old dispute which has come down through the ages, again beginning in ancient times, the difference of opinion between Lucretius and Lactantius. Both agreed that religion is derived from a word which means "to bind," (*ligare*) and which appears also in the word "ligature." But the question between them was whether religion was something that bound man down to things properly beneath him or tied him up to something higher than he. Lucretius' view was that religion ties a man's mind down. What we want is liberty, and in thought only free thought is true. But the conviction of Lactantius was that the mind of man, and his personality, can be tied to something higher than himself as well as to something lower.

This recalls also a contrast we find in the classic work of Cicero: "On the Nature of the Gods," where the earliest extant definition of religion is based on a contrast with superstition. The recent book by Du Nouwy also describes the progress of civilization from superstition to real religion. The function of true religion is to enlarge a man's outlook. How, if we turn our interest in the direction of the infinite, could we fail to enlarge the outlook of the human mind? And to this enlargement we are to give expression in various fundamental ways. Religion should enlighten the human mind, improve human values, and raise the standards of human conduct. I want to call attention to the fact that there is progressive as well as conservative religion. There is a religious interpretation which emphasizes the spirit in opposition to the letter of human satisfaction, which regards religious attitude as more important than the specific creed.

Philosophy and Religion

Religion when it becomes reflective passes to philosophy, as you will see if you note the similarity in conceptions. A generation ago, we found religion defined as the conservation and creation of values. William James, from the philosophic point of view, defined philosophy as our more or less dumb sense of what life honestly and deeply means. It takes no argumentation to point out the similarity of the motives in these statements. And let us acknowledge what is honest in Oriental religion as well as in Occidental, not only in the forms familiar to us, but in forms less familiar, but on study found equally sincere. I do not mean to say the relative values of systems are to be ignored. We still may ask whether all honest systems bring equal results. I mean to say that there is possible a religion to be reached along the road most familiar to us. There is a religion of science, one which is not negative but positive in its attempt at solving the problem—which does not make the two fields exclusive to each other, saying science must keep off religion and religion keep off science, and thus solve their problem. That is not what I mean. That is not what I believe.

I believe there is a positive type of religion free from the limitations of any particular form, but which emphasizes the fundamental spirit of the religious attitude. It is a religion which is not negative but positive, which does not dwell on the mysteries of existence, granting of course there are plenty of mysteries, but which rests its case upon understanding, trying to fulfill the meaning of the first commandment in the Scriptures, "Let there be light." Light on the what? Light on the universe. Light on man. Such a religion may be approached by way of the discussions of such men as Eddington, Whitehead, and Du Nouwy.

Such a view acknowledges the positive side of human knowledge and an interest in humanity, not the negative aspects of existence, but drawing our actual conclusions from what we have achieved. It is a religion which is not ascetic but which gives itself to human service; not self-centered, but having its fundamental thought in loyalty. Fosdick in his statement of the essence of religion in terms of loyalty defines it as that object to which a man gives himself most completely. Cicero, too, in his discussions in that distant day recognized the value of religion in the social order. Some cynics have said that it serves merely for keeping the common man down in his place. But its positive value lies rather in the bond it furnishes, tying human beings together into a group where people support one another in spirituality and in practical cooperation. Cicero, in another happy phrase, said, "Piety, like the rest of the virtues cannot exist in mere outward pretense. With piety reverence and religion must likewise disappear. And when these are gone life soon becomes a welter of disorder and confusion; and I am inclined to think that the disappearance of piety toward the gods will entail the disappearance of loyalty and social union among men as well, and justice itself, the queen of all the virtues."

Experimental Stress Analysis in the Engineering Curriculum

By WALTER W. SOROKA

Associate Professor of Engineering Design, University of California

The severe war-time service imposed on mechanical equipment, particularly in aircraft applications, greatly accelerated the development of the field of experimental stress analysis in industrial laboratories. This development was essential to a proper understanding of the behavior of machinery and structures under service loads well nigh approaching limit loads. Due to the complexity of the problem theoretical analyses were frequently too approximate and too uncertain for such close margins without substantiating evidence from an experimental analysis. It should not be construed from the above that experimental procedures were replacing analytical procedures; the experimental work provided the necessary verification for theory, or else indicated how theory needed to be improved to fit the problem at hand. Experiment without the backing of theoretical preparation is frequently likely to be costly and fruitless; potentially it is dangerous, since it may present only one side of the story and that the wrong side.

This natural and needed supplement to theoretical analysis appears to be spreading more generally into the laboratories of engineering schools. Young stress analysts need to have brought home to them the mutual interdependence of theoretical and experimental methods. They need not only to understand and use the equipment whereby stresses and strains are measured, whereby stress and dynamical models are set up through analogies with other fields, but also to understand and interpret the results so obtained in terms of theoretical predictions for the selfsame problems. They need to experience the limitations and applications of both in order to gain a proper appreciation of the problems they will one day face in hard reality.

A course in experimental stress analysis at the senior level provides the needed opportunity for a review of basic strength of materials and dynamics—a review that is highly effective because the discrepancies between predicted and actual performance cannot always be brushed off with an airy "Experimental errors" but frequently point out fundamental misconceptions in a student's background or lead to a realistic adjustment of a student's "assumptions" in the analytical solution of problems.

Relations Between Strains

Fundamentally, stress is largely interpreted through measurements of strain. In general, these measurements are made at the surface of the part under test. This is a fortunate situation since the most important stresses are likely to occur at the surface. In view of the basic position occupied by strain analysis in experimental stress analysis, the first essential in setting the stage for laboratory work is a thorough grounding in the relations of stresses to strains and of strains to each other. Young's modulus, Poisson's ratio, Mohr's circle, principal strains, become watchwords in the young analyst's vocabulary.

Although in practice the occurrence of systems of strictly plane stress is rather unlikely, nevertheless the analysis of stress on this assumption is so widespread and yields results of such considerable utility that the theoretical and experimental aspects of plane stress analysis provide the backbone of the instruction in this course.

The Mohr circle construction for the state of strain at a point in a two-dimensional stress problem yields the relation

$$\epsilon_{1,2}=\tfrac{1}{2}[\epsilon_x+\epsilon_y\pm\sqrt{(\epsilon_x-\epsilon_y)^2+\gamma_{xy}^2}]. \quad (1)$$

The symbols ϵ_x and ϵ_y represent the longitudinal strains in the directions of the arbitrarily-chosen reference axes x and y. These strains are readily measured by means of mechanical, resistance wire or other strain gages. The symbol γ_{xy} represents the shear strain with respect to the reference axes. Shear strain is not directly measurable with the instruments ordinarily available to the experimental stress analyst. The symbols ϵ_1, ϵ_2 represent the principal strains, which are the values the stress analyst is really searching for. Usually, the directions of the principal strains are not known except through the relation

$$\tan 2\theta_p = \frac{\gamma_{xy}}{\epsilon_x - \epsilon_y}, \quad (2)$$

where θ_p is the angle between the direction of the principal strain ϵ_1 and the reference direction x. The other principal strain direction is, of course, at right angles to this one. If the principal stress directions were always known it would be a simple matter for the experimenter to place his strain gages in those directions, measure ϵ_1 and ϵ_2 and determine the principal stresses, s_1 and s_2 from the relations

$$\begin{aligned}\epsilon_1 &= \frac{1}{E}(s_1 - \mu s_2),\\ \epsilon_2 &= \frac{1}{E}(s_2 - \mu s_1),\end{aligned} \quad (3)$$

where E is Young's modulus and μ Poisson's ratio.

Lack of knowledge of principal stress directions makes it impossible to determine principal stress magnitudes by two strain measurements alone. A third strain measurement is required. Equation (1) indicates this should be the shear strain γ_{xy}. Unfortunately the available gages will not make this measurement directly. The students are shown that the problem may be solved by making a longitudinal strain measurement, ϵ_n, in a third direction making an angle θ_n with the reference axis x. The relationship between ϵ_n and the strains with respect to the reference axes is

$$\epsilon_n=\frac{\epsilon_x+\epsilon_y}{2}+\frac{\epsilon_x-\epsilon_y}{2}\cos 2\theta_n+\frac{\gamma_{xy}}{2}\sin 2\theta_n. \quad (4)$$

If the direction of the third measurement is taken half-way between the directions of the reference axes, i.e., $\theta_n = 45°$, then from Eq. (4)

$$\gamma_{xy} = 2\epsilon_n - (\epsilon_x + \epsilon_y) \quad (5)$$

and the relations (1) and (2) become

$$\epsilon_{1,2}=\tfrac{1}{2}[\epsilon_x+\epsilon_y \pm\sqrt{(\epsilon_x-\epsilon_y)^2+[2\epsilon_n-(\epsilon_x+\epsilon_y)]^2}], \quad (6)$$

$$\tan 2\theta_p = \frac{2\epsilon_n - (\epsilon_x + \epsilon_y)}{\epsilon_x - \epsilon_y}. \quad (7)$$

The three strain measurements necessary for the solution of the problem need not be made as indicated above, but may be made in any three predetermined directions. The combination used above is so convenient and is so easily used in analysis that resistance wire gages are commercially manufactured, in which three independent grids of wire form a single unit, or "rosette," arranged as above. Another commercial rosette arrangement is that in which the three gages are arranged as the legs of an equilateral triangle. These rosettes need but to be cemented to the surface at the point where principal stresses are desired.

Strain Gages

Following this briefing on the strain and stress relations the students are ready to consider experimental means for measuring strain. The operation of tinkages in magnifying slight motions at he gage points into readable deflections of a pointer is readily absorbed. The Huggenberger and the Porter-Lipp extensometers illustrate the basic design and practical use of mechanical strain gages. Student interest is then strongly focused on the bonded resistance wire strain gage. The advent of the fine wire element bonded to a thin paper backing (frequently much smaller than a postage stamp) has resulted in a tremendous expansion of the field of experimental stress analysis. Perhaps no other development has been so instrumental in making possible the detailed analysis of strains under actual operating conditions.

If a fine wire is stretched within the elastic limit, it undergoes an increase in length by virtue of its Young's modulus, and also suffers a decrease in diameter due to Poisson's ratio. For both these reasons the wire resistance should increase, assuming no change in resistivity of the wire material due to the effects of strain. The per cent increase in resistance divided by the per cent increase in length is the strain sensitivity or "gage factor" of the wire. Based merely on dimensional changes, the gage factor is $1 + 2\mu$. For a Poisson's ratio of 0.35, the gage factor should be 1.70. Actually, other unknown effects arise which result in true gage factors differing markedly from the theoretical value. The resistance wire strain gage most commonly in use for static testing has a gage factor of 2.00. Other commercial gages used for dynamic and vibration testing have gage factors in the neighborhood of 3.5.

Blackboard discussions of Wheatstone bridge circuits for measuring the slight changes in resistance due to strain prepare the student for laboratory exercises in the use of resistance wire gages. Changes in gage resistance are due not alone to strain but also to temperature effects. Although commonly made of constantan wire and therefore having an inherently negligible temperature coefficient of resistance, nevertheless the gage is bonded to a part which is likely to vary in dimensions with temperature, thereby imposing on the gage strains not caused by stresses. These temperature strains might in some cases overshadow strains due to stresses. The problem of temperature compensation is resolved by the use of a dummy gage bonded to a block of the same material as the part under test and subjected to the same thermal conditions, or by use of another gage attached to the test specimen and connected in a manner which causes temperature strains to cancel each other in the instrument reading obtained. The latter method is accomplished by placing the two gages so that under the given load they are strained in opposite directions (e.g., top and bottom surfaces of a beam in bending, opposite helices of a shaft in torsion, at right angles to each other on a bar in tension). Temperature compensation in the latter manner leads to increased sensitivity in measurement --double sensitivity in the bending and torsion cases, an increase of 100μ per cent in the axially loaded case.

Static Tests

In the laboratory the students are enabled to verify the operation of strain gages of various types on simple test menbers wherein stresses and deflections could be accurately calculated from the applied loads. These include narrow tension specimens subjected to dead weight loading, a thin-walled tube subjected to bending and torsion independently or in combination, a pivot-ended beam column, a double-cantilever beam, and a beam with partially restrained ends. The application to more difficult structural problems is presented in the measurement of strains in a portal frame, in a ring of rectangular cross section subjected to in-plane and out-of-plane loads, a crane hook, open-section

beams of various forms, a plate subjected to concentrated tensile loads and thin-walled curved tubes subjected to bending.

The strain gages used measure average strain over a finite area of specimen. When stress concentrations are present, the strain might vary so rapidly over this area that the gage reading might well be far below the peak value. This establishes a need for a strain gage of length and width approaching zero. The student is introduced to two methods for approaching this condition. One is the use of brittle coatings sprayed over the test area; the other is photoelasticity. In the former case, various coatings might be used. There is available commercially Stresscoat, a lacquer devised expressly for such work. Students use Stresscoat on a thin plate under uniaxial tension, containing a circular hole and two elliptical holes with major axes at right angles. They follow with increasing load the progress of cracks which appear in the Stresscoat at the calibrated strain. They are able to check measured stress concentrationsa gainst theoretical. A further application is illustrated in the use of Stresscoat on a complicated three-dimensional member such as a gear box casting or a pedestal.

The important use of Stresscoat as an adjunct to the use of resistance wire gages is brought out. The use of rosettes involves considerable time, labor and expense. An appreciable saving in all three might be realized if principal stress directions were known in advance of cementing the gages to the specimen. Stresscoat provides exactly this knowledge, since the cracks appear at right angles to the direction of maximum strain.

In a laboratory devoted to experimental stress analysis the photoelastic method deserves a prominent place. In addition to a pin-point indication of stress distribution at the surface, this method also provides for the determination of stress throughout the interior of the specimen. One of the tremendous advantages of this method is the rapidity with which comparative studies of stress distributions might be made in two-dimensional models of machine parts. Surface stresses are quickly evaluated with the help of a calibration specimen which is preferably part of the model itself. With more work the stress distributions throughout the specimen may be determined. Since in practice only the surface stresses are usually of significance, a designer may evaluate the effects of alternative designs almost as rapidly as the specimens could be machined. Changes in a design may be reflected by corresponding changes in a single photoelastic specimen and the results of these changes photographed successively to form a permanent record on which to base a final decision. Since the photoelastic method does indicate the stress at a point, it is very useful in determining regions of rapidly changing stress, i.e., in evaluating stress concentrations.

Other Tests

Stress distributions due to static loads touch upon only one phase of experimental stress analysis. The student should be introduced to the experimental analysis of problems in the fields of dynamics, elastic stability, thermal stresses and residual stresses. That phase of experimental stress analysis concerned with residual stresses—those due to machining, welding, quenching, etc.—certainly has not received in school laboratories attention commensurate with the importance of the problem.

The cantilever beam, the beam with partially restrained ends and the bent which already have been used for static tests provide an excellent introduction to dynamic strain gage techniques. In each case students obtain hysteresis diagrams under static loading, then apply a periodic force and measure frequency and amplitude in a number of ways, one of which is by the use of a resistance wire strain gage bridge and an oscillograph. The area of the hysteresis

loop provides a measure of damping and its slope a measure of the stiffness of the system. From these data calculations of frequency and amplitude may be made to compare with measured values. An interesting problem is that of measuring and predicting the mode shapes of a pinned-free beam excited by rapidly moving the pinned end through a small amplitude. In connection with the vibration measurements students are faced with the task of estimating the fatigue life of the test pieces.

The buckling of thin cylinders, of plates and columns, and the snap action of bimetal thermostats illustrate a field of problems in elastic stability. With regard to residual stresses the measurement technique is not as straightforward as in the other cases. Here the strain gage or brittle coating is applied to the specimen and then the stress relieved by carefully drilling a hole in the specimen. The appearance of cracks in the brittle lacquer or an indication of strain by the strain gage provides a measure of the original stress present in the member.

X-ray diffraction methods for evaluating residual stresses are discussed. However, the apparatus is highly specialized and not generally available to stress analysts.

Models

It is not always possible to apply experimental techniques directly to the specimen of interest. The specimen may be unavailable, it may be too costly, or it may not be possible to place measuring devices on it. In such cases a model of the specimen offers considerable advantage. Photoelastic models already have been discussed. Other types of models include wire models for structures and plaster models for the study of castings. In problems of stress and dynamics the electrical model provides a convenient method for studying the effects of variations of parameters. In the study of stress distributions the models are thin conducting sheets, either electrolytic or metallic. In the study of vibration problems the models are electrical circuits consisting of inductance, capacitance, resistance and source of electromotive force. With several variable elements available, hookups may be rapidly accomplished for studying a wide variety of impact and vibration problems.

Sections and Branches

The **Allegheny Section** of the American Society for Engineering Education met in the Cathedral of Learning, University of Pittsburgh on Friday, April 22, with Prof. R. C. Gorham, chairman, presiding.

The program included talks by Dean E. A. Holbrook, President C. J. Freund, Professors G. Boomsliter and W. G. Crouch. The theme was "Bridging the Gaps."

The following officers were elected for the coming year: Chairman, D. M. Griffith, Bucknell University; Vice-Chairman, D. F. Miner, Carnegie Institute of Technology; Secretary, W. D. Garman, Bucknell University; Representative on General Council, W. A. Koehler, West Virginia University.

Industry Develops Engineers*

By T. B. JOCHEM

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Editors' Note: **The following three papers are condensations of reports prepared by the Milwaukee Section of the A.S.M.E. on the general subject of aptitude testing and training of engineers in industry. A considerable amount of attention has been given to aptitude testing of incoming college freshmen, but very little attention has been devoted to this subject at the exit end of the college career.**

The development of the engineer is a joint responsibility of the colleges and industry. During his college years the student can hope to acquire little more than a thorough knowledge of engineering fundamentals. After graduation, the engineer is faced with the problem of bringing the basic knowledge into harmonious relationship with practical application. It is precisely here that the young engineer needs the guidance of a well-defined training policy in industry.

Industry, since it draws heavily on the accumulated knowledge of the engineering profession, has a definite responsibility to promote and add to the store of engineering knowledge. By continued development of its engineering personnel, industry is discharging this duty in a most effective manner. Training in specialized phases of the engineering profession can best be provided in industry itself where this specialization is at a high level. In fact, this training is necessary for the most effective use of the student engineer's talents. The fact that the engineer is devoting to industry unique and individual abilities, potentially unlimited in their capacity to promote advancement of a company in its field, justifies no small effort on the company's part in training the engineer for maximum effectiveness.

The Survey

In order to obtain information on the methods employed by industry in the Milwaukee area in training engineering personnel, a questionnaire was submitted to 75 companies requesting information on their programs in this regard. Answers were received from approximately ½ of those contacted. These answers were analyzed and the information grouped under four general headings: Cooperative Training, Graduate Student Training, In-company Activities for Engineering Personnel, and Out-company Activities.

Cooperative Training

Marquette University in Milwaukee provides a cooperative training course in its Engineering College involving three month periods of alternate work and study. The student enters the program at the completion of his sophomore year and continues on the plan until graduation. Approximately 40 companies are cooperating with Marquette under this plan.

*** Abstract of the paper presented before the Educational Session of the A.S.M.E. Convention, June 2, 1948.**

Graduate Student Training

The survey revealed the following graduate training procedures:

(1) 27% of the companies provide a well integrated program involving work in various departments coupled with lecture periods.

(2) 20% provide the work program but omit the lecture course.

(3) 12% depend upon a limited training under the supervision of the engineer's immediate superior.

(4) 41% provide no formal training of any kind.

In-company Activities for Engineering Personnel

(1) All companies listed conferences and meetings in the home office as a method of personnel training.

(2) 75% of the companies distribute magazines, patents and letter releases on new products.

(3) 50% regard attendance at conventions and industry meetings of importance in personnel training.

(4) 15% provide specialized training, engineering, economic and social, at an advanced level.

Out-company Activities

(1) 75% of the companies encourage membership in local and national engineering organizations. 10% stated that all or part of the dues are paid by the company.

(2) 35% encourage the engineers to prepare papers for publication and presentation at technical meetings.

(3) 50% sponsor or actively encourage their employees to enroll in specialized and advanced courses in educational institutions. 25% pay all or part of the course fees.

(4) 50% of the companies encourage their engineers to attend meetings and technical sessions of engineering groups and to actively participate in organization affairs.

It is apparent from the survey that only about 50% of the companies are providing facilities for developing engineers beyond the college level. That such training is necessary seems obvious. A program of a more or less formal nature is possible in all companies, large and small. Briefly, such a program should include:

(1) Orientation—acquainting the engineer with the company, products, etc.;
(2) On-the-job training for at least short periods in each department;
(3) Lectures discussing the company products with emphasis on engineering aspects;
(4) A testing of the student's knowledge at regular intervals; and
(5) Final training in the department to which the engineer is assigned.

A program of this nature, including all the phases but modified in details to fit into a particular company's organization, will provide effective and profitable training to new engineering personnel.

Advanced training procedures are open to considerable variation. Those listed above indicate the general trend in an area in which there is a wealth of opportunity for development of engineers in the form of numerous technical organizations and excellent educational facilities at the post-graduate level.

Milwaukee Plan of Aptitude Testing*

By E. C. KOERPER

Research Coordinator, A. O. Smith Corporation, Milwaukee, Wisconsin

What are the basic differences between the abilities of individual engineers? Wherein is the difference between a researcher, a development engineer, a production engineer and an engineering supervisor?

Much effort has been devoted to the problems of guiding, selecting and training engineers. However, something seems to be lacking. Generally it is felt that most current personnel selective methods involved one or more of the following shortcomings:

1. The utility of proven psychological test batteries is limited in that the short batteries tended to be merely "go and no go gages" and the long batteries tended to become mere statistical summaries of psychometric jargon. 2. The use of patterned interviews was lacking. 3. The engineering jobs were poorly specified. This gave an inadequate basis for matching personal characteristics to job requirements. 4. The growth factor of the engineer was disregarded. 5. The broad terminology of the test batteries, patterned interviews, job specifications and progress evaluation lacked uniformity.

Plan Objectives

The viewpoint and approach of the Professional Development Committee of the Engineers' Society of Milwaukee was primarily professional in that the objectives were the better selection, placement and development of engineers and engineering administrators toward their more effective utilization and recognition. The academic and industrial viewpoints were closely integrated into it. The categories of "Engineers and Engineering Administrators" are jointly treated because of merging interests.

After two years work the "Milwaukee Plan of Personnel Development in Engineering" was defined to cover the following related objectives:

1. Develop effective means for assaying and specifying the aptitudes, interests and personal qualities of individuals in all the variously related fields of engineering work.

2. Develop a comprehensive job specification system for all engineering jobs to be used in conjunction with selection, guidance and training procedures.

Participation and Areas of Interest

In carrying out this rather ambitious program, believed to be the first of its kind, every effort was made to be scientifically sound—yet practical and broadly applicable. Toward that end the viewpoints, abilities, judgment and the efforts of the University, Industry, the Professional Psychologists, and the Professional Engineer were closely integrated.

Program Activity

The Plan revolves around the following:

1. Psychological test batteries and their refinements.
2. Patterned interview forms and techniques as an aid.
3. Comprehensive workable job specification system to cover virtually all engineering jobs with lay descriptive

* Condensation of Paper Presented at A.S.M.E. Education Session, Semi-Annual Convention, Milwaukee, June 2, 1948.

terms common to test batteries and patterned interview.
4. Employee progress appraisal methods.

Basic Factors or Traits

It was felt that if terms were kept sufficiently broad the basic characteristics of individuals and job requirements could be described by the following three characteristic groups of factors or traits:

Preponderantly Technical

1. Comprehension of engineering principles
2. Level of technical knowledge
3. Mathematical aptitude
4. Organization of technical work
   a. For own execution
   b. For execution of others
5. Knowledge and preparation of engineering plans
6. Ability to deal with critical technical details
7. Scientific and research ability
8. Clarity of expression in
   a. Speech
   b. Writing

Preponderantly Psychological

9. Self reliance and drive
10. Social intelligence and tact
11. Sales ability and interest
12. Leadership in work direction
13. Dependability in engineering work
14. Professional aspiration and development

Physical

15. General physical characteristics, conduct and appearance

Progress

The following recommendations and references, ready for use, are obtainable from the Professional Development Committee or from the ASME Headquarters in New York:

Aptitude Test Batteries—A Summary **ATB-1**
Preliminary Criteria for Trait Evaluation **PC-1**
Patterned Interview—Outline Form **PIF-1**
Job Specification System—Preliminary Outline **JS-1**

Continuing the Plan

The application of the Plan can be carried on advantageously in the three following areas:

1. Engineering schools: A student's personal qualifications are just as important as his academic accomplishments.
2. Industrial companies cooperating with all or any part of the Plan.
3. Engineering societies for professional development and guidance for its members.

The integration of these efforts will help to develop the untapped potentialities of the engineer. His place is critical in our modern industrial civilization which becomes more complex hourly. If we as engineers or teachers adequately utilize and direct our abilities we can take a leading place in developing the greater destiny of mankind. We must not do less.

Most of the credit for this work goes to the following hard working committees and their chairmen:

Test Batteries:

Dr. K. U. Smith, Department of Psychology, University of Wisconsin (Chairman).

Dr. G. S. Speer, Director, Institute for Psychological Testing, Illinois Institute of Technology.

Dr. Carl Wedell, Director, Bureau of Industrial Psychology, University of Madison.

A. C. Siebers, Director, Marquette University Guidance Center.

Job Specification System:

R. Falk, Vice-President, The Falk Corporation (Chairman).

Patterned Interview:

E. C. Ulbricht, Employment Manager, Cutler-Hammer, Inc. (Chairman).

University-Industry Relations in Developing Engineers*

By WALTER P. SCHMITTER

Chief Engineer, The Falk Corporation
Milwaukee, Wisconsin

Engineering training which aims at a realistic interpretation of the technical and sociological needs of modern complex society requires thorough correlation of the primary teaching pursuits of the university with the integrational efforts of industry.

Current surveys indicate the absence of adequate cooperative activity in the several fields of engineering education and training. On the undergraduate level, an occasional talk, plant tour or summer employment sums up industry's part in academic training. The undergraduate co-operative aims in the right direction, but suffers from under-development. Undergraduate evening college, sub-college engineering training and engineering correspondence courses are left almost entirely to individual initiative. Graduate engineering training, whether well developed or informal, is usually taken over entirely by industry. Post graduate education includes industrial co-operation only when students work on industrial research projects.

It is industry's place to foster co-operation with the universities by giving expression to their requirements and by adequately training the young engineer after he enters the industrial field.

In order that the entire field of engineering education and training be fully re-explored, a broad gage national committee, representing industry and university, should be established with adequate funds for fulltime research and study. The objectives must include:

1. Training of engineers in creative thinking; development of enterprise and resourcefulness.
2. Providing more practical development; more actual skills rather than potential ones.
3. Reducing the overall time required to produce an engineer capable of assuming responsible charge of engineering projects.
4. Instilling cultural values, social attitudes, and the kinds of loyalties essential to a healthy industrial fellowship.

Much of the activity carried on in engineering colleges can be relegated to preparatory schools. All of the basic instruction in elementary machine shop, pattern shop, foundry and weld shop could be obtained in the technical high school at an age where interests should be stimulated. Such preparation would permit more advanced and more practical instruction in the university to the degree that student engineers could participate in actual industrial cooperative endeavors. Many industrial problems could be delegated to the laboratories of technical schools and under certain conditions consulting help from the staffs could be utilized.

Fundamentals, rather than specialization and non-essentials, should be stressed in the University. Specialized and ap-

*** Condensation of paper presented at the A.S.M.E. Semi-Annual Meeting, June, 1948.**

plied subjects should be condensed and confined to the basic courses and more intense study given to mechanics and technological methods.

Since an engineer's greatest value is in his creative talent, original thought should be encouraged in the university. The trainee should have less respect for prevailing concepts as to what cannot be done.

Although technical knowledge is primary, the cultural background essential to development of the "whole man" should be grounded in the scholastic environment of the university.

The present tendency to draw industry and university together is reflected in academic membership for professors in manufacturing associations, as well as several cooperative programs currently shaping up. Milwaukee industry and the University of Wisconsin are cooperating on a plan for a Master's Degree in Engineering for industrial men; however, each works independently in many respects. Master's "in industry," the Allis-Chalmers Plan, is a highly developed program arranged with Illinois Institute of Technology. Key-man training, the Falk Plan, provides intensive education in company operations with monthly, all-day seminars under professional guidance.

A reoriented, co-ordinated program for development of engineers can be expected to provide men who will make essential contributions to the technical resources of society and also exhibit a civic consciousness along with a quiet devotion to the American pattern of life.

College Notes

The appointment of Albert G. Hill as director and Jerome B. Wiesner as associate director of the Research Laboratory of Electronics at the **Massachusetts Institute of Technology** was announced by Dr. James R. Killian, Jr., president of the Institute. Professor Hill, who has been associate director of the laboratory, succeeds Julius A. Stratton, whose appointment as provost of the Institute was announced recently. Professor Wiesner has been assistant director.

Pomona College of California and Wesleyan University in Connecticut have joined the **Massachusetts Institute of Technology** in a plan for combined liberal arts and technological study, Dr. James R. Killian, Jr., President of the Institute, announced. The combined plan of study now includes 14 liberal arts colleges, all of which cooperate with the Institute under a plan jointly established in 1936. Under the arrangement, students of high academic standing may pursue a specially-planned course for three years in any of the participating liberal arts colleges and then complete the requirements for a science, engineering, or city planning degree in two years at the Institute. A degree in architecture requires three years' additional study at M.I.T. Both a B.S. degree from the Institute and a B.A. degree from the liberal arts college are awarded on completion of the program.

Carl C. Chambers, professor of electrical engineering at the **University of Pennsylvania**, has been appointed acting dean of the University's Moore School of Electrical Engineering for a one-year term it was announced yesterday by Harold E. Stassen, President of the University. Dr. Chambers will succeed Harold Pender who has had a distinguished career as Dean of the Moore School since 1923 and who will retire from the deanship on July 1st, when Dr. Chambers' appointment becomes effective. Dr. Pender, however, will have association with the University as consultant.

Writing Technical Reports*

By KENNETH A. KOBE

Professor of Chemical Engineering, University of Texas, Austin, Texas

The "problem" of teaching a student to write technical reports so that industry is satisfied with the man when he comes to them is one which has been treated with varying degrees of indifference. Yes, its importance is recognized and most schools attempt to do something with varying degrees of success but the complaint of industry has not changed. Back in 1937 *Chemical Industries* ran a series of articles (*1*) on "Why Chemists Get Fired," and the statements presumably apply to all technical men. A criticism repeated again and again by executives of chemical companies can be epitomized by the statement of Robert E. Wilson, then president of the Pan-American Petroleum and Transport Company and now Chairman of the Board of Directors of the Standard Oil Company of Indiana, "In my experience the greatest weakness of the average chemical engineer today is in the lack of ability to assemble a good report which is at once well organized, clear and persuasive."

That the complaint in 1948 is no different than in 1937 is shown in an editorial (*2*) which summarizes the statement of a number of executives. Willard Dow, President of the Dow Chemical Company states: "The average engineer is most inadequately equipped to express himself in the English language."

This criticism is not directed merely at the four-year graduate. The American Chemical Society Committee on Professional Training found in its survey of graduate training at the doctorate level (*3*) that chemical industrial research executives were still asking for the same thing: "Industrial research is badly in need of men who possess . . . the ability to express conclusions and substantiate them convincingly, either orally or in writing and in terms adapted to the background and thinking processes of those addressed."

The situation is one that calls for consideration, discussion and positive action on the part of engineering faculties. Possibly there has been too much discussion, which led Dean Sherwood of MIT to close the round table discussion on Chemical Engineering Education at the Detroit meeting (1947) of the AIChE with the remark: "We had better adjourn before someone brings up the subject of report writing." Can Mark Twain's quip about the weather be transposed to us on report writing? Are we always talking about it but never doing anything?

Special Knowledge or Literature Appreciation

Two attitudes towards technical report writing appear to be prevalent. The first, frequently held by technical men, was recently presented in an article by Nichols (*4*):

> "In order to write a good technical report, the author must thoroughly understand the subject upon which he is reporting. Bad technical reports are almost always the result of inadequate understanding of his subject by the author."

* Revised from a paper presented before the ASEE Summer School for Teachers of Chemical Engineering, Madison, Wis., Aug. 30, 1948.

That this view is not shared by the professor was shown by letters of protest to the editor.

The second attitude is that frequently held by members of departments of English who have had but slight contact with technical men and their needs. They believe that if the freshman engineer is presented with the fundamental principles of intelligent writing and careful reading of masterpieces of English literature, then he should be able to present his ideas clearly and logically in a technical report. Most technical men will refute this viewpoint.

What is Being Done

Before a solution to the problem is proposed, let us examine what is being done by the departments of English and of chemical engineering in the 53 schools accredited by ECPD in chemical engineering. A questionnaire was sent to both departments in each school and the replies were tabulated. They show:

Schools requiring a special course in technical writing	15
Schools having available as an elective a course in technical writing	13
Schools at which no such course is available	25
Total	53

It is seen that about one quarter of the schools believe that a course in technical composition above the freshman level is sufficiently important so that it is required, another one quarter of the schools have such a course available as an elective, but one half of the schools do not consider technical writing to be of sufficient importance to offer such a course to technical students.

The departments of chemical engineering claim that they are not derelict in their duty, they "make the student write reports." Usually the preparation of chemical engineering reports is in connection with courses such as unit operations laboratory, plant design, process development, special problems or thesis. The department gives the student some instruction sheets that show the form desired and prescribe certain arrangements and information that must be present in the report. The standard of excellence required for reports varies from school to school and from instructor to instructor within the school. The correction of the report and the assistance given to the student to enable him to improve his work again vary greatly, particularly with the interest, ability, and time available to the instructor who grades the report. The instructor usually gives the grade on the basis of the technical material contained in the report and the correction of report form and composition is incidental to the technical material. Frequently the instructor is a graduate student in chemical engineering whose training in English is no greater than that of the student whose report he is grading. It may be a case of the blind leading the blind. This practice does not permit the student to have the benefit of advice from someone skilled in the use of English and particularly in technical reports.

What More Can Be Done

There is no doubt that the various engineering departments have in their reports for laboratory work, design, special problems and the like, the mechanism by which report writing excellence can be ingrained into the student. There is a number of ideas that must be adopted by engineering departments in order to achieve the desired results.

The attitude of every engineering instructor must be that report writing is of the utmost importance. Every instructor must impress his students with the fact that reports must not only be satisfactory technically but also satisfactory as a report. Reports not in proper form or unsatisfactorily written should be returned for correction before the technical material is graded. In answers to the questionnaire previously mentioned the instructors in English frequently mention as a hindrance to good report writing the indifferent, or worse, attitude of

the engineering instructor. This attitude cannot be tolerated by a department or college of engineering.

A form sheet showing how the instructor desires the report presented should be given to each student. Some may decry this as copybook work and refuse to use such forms for fear of "stifling the initiative of the student." To show a man one way of doing a thing correctly does not stifle his initiative, and this procedure is used in industry. The student is told that a certain report form is required for a laboratory course and another form is required for a special topics course. He is shown a number of report forms used in industry so that he can see their variation from company to company. He sees that no one form meets all requirements of industry and that he must be sufficiently adaptable to satisfy whoever may be his employer. At the University of Texas every instructor in chemical engineering operates a department of the hypothetical Unitex Engineering Corporation. In Ch.E. 64, Unit Operations Laboratory, the instructor tells the student that Department 64 desires his experimental work to follow a certain form; in Ch.E. 378, Organic Technology, the student is told that Department 378 desires his economic and engineering surveys to follow a more formal form suitable for a client of a consulting firm. The attitude of the instructor and the form sheets given the student (when illustrated by form sheets used in industrial concerns) leave no doubt in his mind that he must produce good reports.

An assistant trained in English should be added to the staff of every technical department. This man or woman should possess a thorough training in English, preferably be majoring in this subject, and have a liking or sympathy for technical composition. Most of all he should have the desire to see the technical students improve their English under his supervision. The engineering instructor is perfectly competent to correct the mathematics that his students use, but his shortcomings in English must be realized by himself and his departmental administration so that proper assistants can be hired. †

This plan has operated successfully in chemical engineering at the University of Texas. The department decided that it would provide an assistant who would review the unit operations laboratory reports for English. This consisted of more than reading the report and marking misspelled words and improper punctuation. The assistant was provided with a number of small rubber stamps ‡ that provide a notation for the most common errors found in the report. In addition to the stamped or written notation, small paper slips are provided that contain a short statement of the correction necessary. In this way the student learns what is wrong and, more important, how it should be done correctly. Failure to provide this latter material is the common error of present corrections made by technical men. The report is given a rating in English by the assistant who evaluates this before the report is graded for technical content. The course instructor then grades the technical content and gives the report a final rating. The student may have a conference with the assistant if he desires

† The survey showed that at two schools excellent cooperation existed between departments in engineering and English. At the State University of Iowa a grader is supplied by the Department of English for under-graduate laboratories in mechanical and electrical engineering. Each report is graded for English and fifteen per cent of the final grade is allotted to composition. At the University of Washington, laboratory reports may be sent to the Department of Humanistic-Social Studies, a department within the College of Engineering, to be graded. As many as 4000 technical papers have been corrected during a year. The technical instructor may use the corrections as he sees fit.

‡ This system was introduced to the writer by Professor A. V. Hall of the Department of Humanistic-Social Studies of the University of Washington, Seattle.

to discuss his report and secure further suggestions for its improvement. Student reaction to this system has been favorable because it helps them improve their technical writing.

What Can Industry Do?

Industry itself is not entirely blameless when it criticizes an employee for an inability to write a report acceptable to the particular company for which he works. What has it done to help this man write better reports? If industry places the emphasis on report writing that it apparently does, then it too should have a program to train the new employees to write satisfactory reports.

Industry must make its attitude known to the undergraduate student. The instructor can repeat time after time to the student that industry wants clear, concise reports, but the student still regards the remarks as triviality. Let the personnel representative from the large corporation make the same remarks, let him inquire of the student being interviewed as to his ability to write reports, then this matter assumes an importance in the mind of the student. If industry wants men who can write good reports it must help convince the undergraduate student that he must write good reports in his technical courses.

When the new employee is called upon to write his first report, he usually has for a guide a report previously written by some member of the organization. It may have in it all of the faults about which industry complains. Each company should prepare a report on report writing that can be given to the new employee to show him what is wanted.

The report on report writing should be supplemented by several classes on report writing. The men who are demanding good reports should tell their subordinates what they want and what the writer should do to produce excellent reports. If the executive is unwilling to take the time or cannot tell his men what he wants, then his criticism of their efforts is unjustified.

Summary

Students in technical courses will produce excellent reports if (1) they are shown what is expected in a report, (2) they are convinced that the instructor will accept only a good report, (3) their report is given constructive criticism by competent individuals. Such attitude and supervision have proved that engineers can write good reports.

Industry itself should set up a constructive program to assist the young engineer in learning the forms and peculiarities of the company for which he works.

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A New Teaching Aid in Mechanics*

By D. T. WORRELL

Assistant Professor of Mechanics, West Virginia University

The SR-4 Electric Strain Gage has been used widely in research but this versatile tool should not be overlooked as a means of demonstrating the principles of mechanics to students. To this end, a small beam with SR-4 gages attached, together with associated equipment, is used in the classroom at West Virginia University—first-hand evidence to the student of stress, strain and moment distribution in a beam.

The instructor makes this demonstration after the students are drawing moment diagrams. The beam is placed on supports, the other equipment set up and the gages balanced with no load on the beam. The students are asked to specify the loading, which is made with several small, hooked, flat weights for uniform load and larger weights for concentrated load. The moment diagram is drawn for this loading. Students then operate the switching and read the output of the gages, which are closely spaced all along the length of the bottom of the beam. When the class sees a plot of the gage readings versus length along the beam and its agreement with the moment diagram previously drawn, something of the mystery and mental reservations associated with moment diagrams seems to disappear.

Later the same apparatus can be used to show the effect of fixed ends (and the difficulty of attaining perfect fixity), of overhangs, and of more than two supports. Superposition is demonstrated by rebalancing the gages after one load is in place, then reading the gages after a different kind of load is added. Gage output will be for the additional load only.

In the laboratory where heavier loads are available from testing machines, gages spaced along the depth of a beam may prove to students that stress and strain vary directly as the distance from the neutral axis. At the same time stresses calculated from measured strains by $s = E\epsilon$ are used to verify the flexure formula $s = Mc/I$ within 1%.

The beam used in the classroom demonstrations is of steel, $1\frac{1}{2}''$ wide, $\frac{3}{16}''$ deep and $27''$ long. Concentrated loads of 30 pounds or distributed loads of 3 pounds/inch produce stresses of the order of 15,000 to 20,000 psi. Type A-1 gages

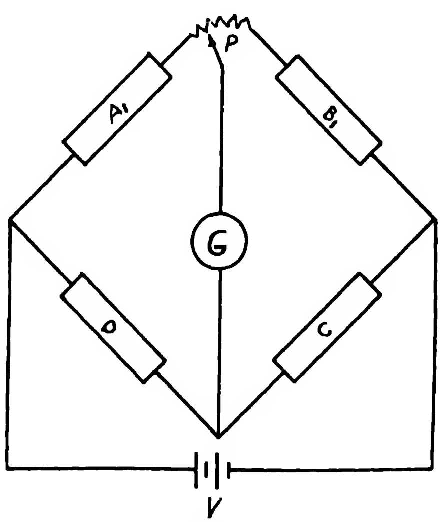


FIG. 1.

* Presented at Allegheny Section Meeting, ASEE, Morgantown, W. Va., October 16, 1948.

were attached to the bottom of the beam, spaced 1½" apart. (Future design should consider shorter gages on aluminum.)

The basic circuit is the Wheatstone Bridge of Fig. 1. A_1 is an active strain gage; P is a commercial 2 ohm potentiometer for coarse balance of the bridge; B_1 is a strain gage mounted on a small cantilever beam, the end of which is forcibly deflected by a screw to obtain fine balance of the bridge; C and D are inactive strain gages; G is a sensitive galvanometer (0.059 micro-amps/mm) and V is a 6 volt lead storage battery.

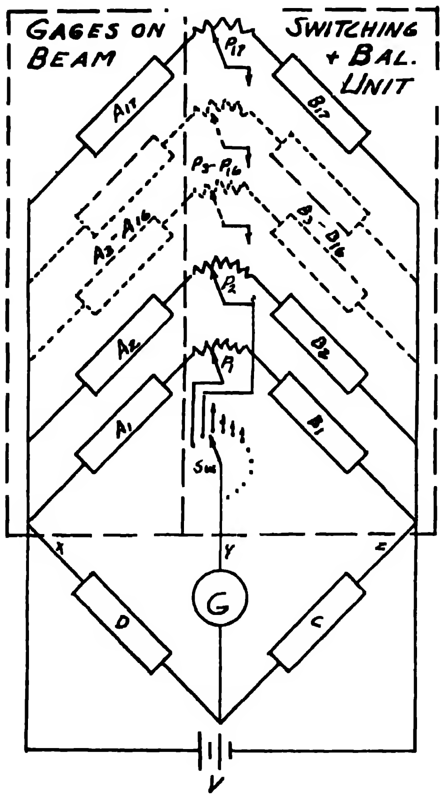


Fig. 2.

For seventeen active gages on the beam, seventeen bridges are needed. With legs C and D common to all, A_2, P_2 and B_2, A_3, P_3 and B_3, etc., are connected parallel to A_1, P_1 and B_1 as shown in Fig. 2. The moving arms of potentiometers P are connected to a seventeen point selector switch. The legs B and their cantilevers, the potentiometers P and the selector switch are all mounted in a single switching and balancing unit. Standard octal radio tube bases and sockets are used to connect the cable from the gages on the beam to the balacing unit. The SR-4 Control Box galvanometer was used in this apparatus and contains the legs C and D; x, y, and z of Fig. 2 correspond with the lettering A, C and B respectively on the terminals of the Control Box.

For a demonstration, all connections are made, the beam placed on supports, the selector switch set to each position in turn while the coarse and fine balance are used to zero the galvanometer. (Reduced voltage is used until a coarse balance is obtained on all bridges.) Then with any load on the beam, the selector switch set at each position in turn, the galvanometer deflections read are proportional to bending moment along the beam.

The Mechanics Laboratory*

Should It Be a Materials Testing Laboratory or a Place for Demonstrating the Principles of Applied Mechanics and Strength of Materials?

By FRANKLIN L. EVERETT

Associate Professor of Engineering Mechanics, University of Michigan

The title of this paper is so complete in its description of the subject, and your acquaintance as engineering teachers with the operations of the mechanics laboratory so general, that it hardly seems necessary or possible to add much new material here. However, it is possible that such a paper as this may help to give the very old subject of the mechanics laboratory a refreshed interest.

For the purpose of this paper, it appears best that consideration be excluded upon such laboratory subject matter as statics, dynamics, vibrations, hydraulics, fluid mechanics, fatigue of metals, creep of metals, photoelasticity and graduate or special research works. The scope of this paper will, therefore, be confined to the laboratory experiments and instruction associated with the theory course commonly known as Strength of Materials.

In order that we may be better qualified to appraise later the mechanics laboratory situations which may offer the greatest advantages to the students in engineering, we should properly examine the present courses which are being given in testing the elastic properties and strength of engineering materials. As a basis for study, an analysis was made of the work which is being done in the mechanics laboratories of the one hundred twenty-nine engineering colleges in which there exist accredited courses of instruction according to the 1943 Report of the Engineering Council for Professional Development.

The latest available catalogues of all 129 engineering schools having accredited departments were studied. From the published description of the courses offered by these schools, it was found that mechanics laboratory courses were offered in 110 or 85 per cent of these schools. It was decided to resort to the use of information from the school catalogues rather than to obtaining data from direct questionnaires addressed to the instructors. Complete data were easily accessible without introducing the possibility that the information would be influenced because it was known to be used in a specialized camparative study.

Extent of Mechanics Laboratory Courses

The study revealed that the mechanics laboratory courses were being taught in the various departments as follows:

Department	Mechanics Laboratory Offered in Schools No.	%
Civil Engineering	54	49
General Engineering	7	6
Mechanical Engineering	17	16
Mechanics	22	20
Other	10	9
	110	100

* A paper presented before the Mechanics Division of the American Society for Engineering Education, Annual Meeting, Austin, Texas. June 16, 1948.

It is seen that in about one-half of the schools, the Civil Engineering Department is responsible for the instruction of whatever students take the laboratory work in mechanics. It is probably a reasonable assumption that the teaching is largely from the viewpoint of the Civil Engineer.

The number of credit hours allowed toward graduation varies in the different institutions. In order to approximate a standardized basis for comparing the amount of academic credit, one hour of credit was assigned for each hour of lecture and one credit hour was assigned for each three clock hours of laboratory work. The distribution of credit allowed for mechanics laboratory courses is given as:

Hours of Credit	Schools Offering Mechanics Laboratory No.	%
1	62	56
2	25	23
3	9	8
Questioned	14	13
	110	100

The catalogue description is some cases left some doubt just what work was regarded as theory and what as laboratory. Although in the majority of schools one credit hour is allowed for the mechanics laboratory, it is significant that many schools devote a substantially greater amount of time to this work.

Content of Courses

A careful reading was made of the subject matter given in the catalogue description of the mechanics laboratory. The following classifications of the content of the courses were based on designating the term (1) "Testing Materials" to include work mainly of the kind wherein destructive tests were made of materials and where also standard A.S.T.M. specifications were studied and the term (2) "Principles" to mean tests and demonstrations of chiefly elastic behavior of elementary structural and mechanical members under various types of loading in direct correspondence to the usual subject material covered in the theory course in Strength of Materials. The nature of the laboratory work can be seen in the following table:

Nature of Mechanics Laboratory	Schools No.	%
Testing Materials	63	57
Principles	0	0
Testing Materials and Principles	33	30
Questioned	14	13
	110	100

It is obvious that testing materials is taught in most schools and it is probably a fair presumption that some testing materials is a part of all mechanics laboratory courses.

Textbooks

A further investigation of existing conditions relating to instruction in the mechanics laboratory was made by examining the textbooks and laboratory manuals. Various publishers of engineering books were asked to suggest what suitable books and manuals they offer.* Replies were received from all of the publishers and the summary of the study of available laboratory books is as follows:

Subject Matter	Mechanics Laboratory Books No.	%
Testing Materials	4	44
Principles	1	12
Testing Materials and Principles	4	44
	9	100

Practically all of the textbooks and manuals generally available for instructional purposes in the mechanics laboratory deal with the testing of materials. It is known that, in addition to the above books which were covered, there do exist notes, pamphlets and other locally used laboratory literature. It appears that there might be room for other laboratory books and manuals primarily directed to-

* See bibliography at end of paper.

ward encouraging laboratory exercises and demonstrations of the fundamental principles taught in the theory course of Strength of Materials.

Paradox

There is undoubtedly very sound reasoning behind the teaching of testing materials. Materials used in the construction of structures and machines will fail either by excessive distortions or by actual fracture if they are subjected to too great loadings. It is the responsibility of the design engineer to anticipate the loads and other operating conditions and to employ materials and shapes which can be expected to withstand the imposed situations. The testing of materials to ultimate destruction, like the subject of Civil Engineering as a whole, possesses that pioneering attribute wherein a broad picture of the new unexplored situation must be gained with reasonable speed, effort and economy. The general characteristics of materials under various types of tension, compression, bending and twist can be determined in the testing materials laboratory.

Like the professional fields which deal in detail analysis such as mechanical, aeronautical, mechanics, it appears that much is to be learned of the fundamental behavior of structures and machine parts which are stressed elastically in practice. Furthermore, the mechanics laboratory has become associated with the theory course in Strength of Materials. Perhaps there is a chance for some confusion in our thinking because in the theory course of Strength of Materials practically all of the subject matter deals with the elasticity of materials and a negligible amount of time is spent on the strength properties of materials. In the mechanics laboratory course, however, it is the common practice to devote the prime effort to tests beyond the limit of elasticity. Former Dean M. E. Cooley of the University of Michigan in emphatically describing the early days of the mechanics laboratory said, "They broke just about everything they could find."

Content of Modern Laboratory Courses

The mechanics laboratory which would be devoted to teaching students the principles commonly formulated in the theory course in Strength of Materials should properly include various basic test exercises, demonstrations and models which can be loaded in the elastic range. The student should be able to see easily for himself the type of elastic distortions that result from the loads he himself applies, what distortions occur, and he should determine with simplest means the stresses which are induced as a result of the loadings. The idea of permitting the student to work as an individual is important. His acquaintance with the test model should be intimate and should not be as a member of a larger group to which the demonstration is made by a teacher. The testing apparatus consisting of the machinery and auxiliary apparatus should be made an insignificant part of the exercise. As far as possible, loadings should be made by means of dead weights and deformations should be read on scales and protractors.

Examples of Exercises

A few examples will be given of test exercises which may be presented to the student in the mechanics laboratory devoted to a study of the principles of strength of materials.

The simple tension of a rod is illustrated in Fig. 1. The student can take the measurements of the wire. Either the deflection, δ, of the weight can be

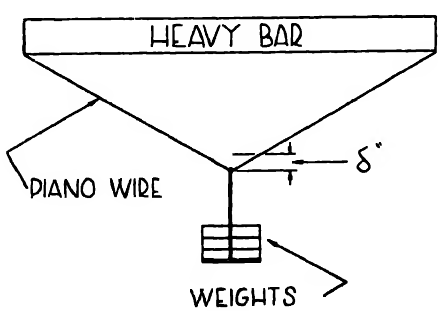


FIG. 1. Wire in tension.

calculated by assuming a value for the modulus of elasticity, E, or the value E can be determined by measuring δ for test values of the load. The angle α of inclination of the wires with the horizontal can be varied. It should be noted that the relation between the various factors is given by:

$$\delta = \frac{Wl}{2AE\sin^2\alpha},$$

in which W is the load and A and l the area and length of each wire respectively.

A thin cylindrical drum with hemispherical ends serves to demonstrate strains which are influenced by the Poisson's ratio, μ, effect. The strains, which may be observed by means of electrical strain gages, for instance, as shown in Fig. 2, are found to be:

$$e_1 = \frac{pr}{2tE}(1 - \mu) \text{ on the hemispherical ends,}$$

$$e_2 = \frac{pr}{2tE}(2 - \mu) \text{ circumferentially on the cylindrical wall,}$$

$$e_3 = \frac{pr}{2tE}(1 - 2\mu) \text{ longitudinally on the cylindrical wall,}$$

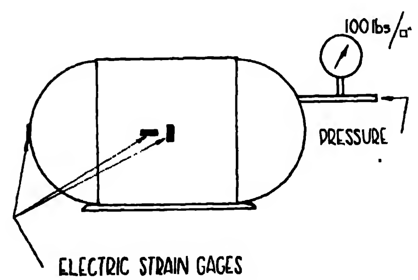


Fig. 2. Thin drum with internal pressure.

where p is the internal pressure, r the average radius and t the wall thickness. It should be noted that the stresses are not simply found by multiplying these strains by the modulus of elasticity E. The stresses are:

$$S_1 = \frac{S_2}{2} = S_3 = \frac{pr}{2t}.$$

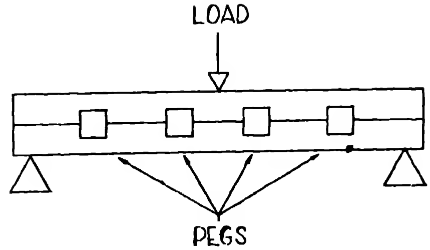


Fig. 3. Horizontal shear in a beam.

Horizontal shear in a beam is demonstrated by the use of such a model as shown in Fig. 3. If the well-fitting wedges or pegs are removed the maximum deflection of the beam is four times the deflection when the wedges are in place. The student will readily observe that the wedges play an important part in preventing sliding.

A cantilever beam kit of pieces of various cross-sections, Fig. 4, will furnish a considerable help in the study of deflections. It should be made possible to rotate the fixed end of each beam so as to permit various orientations of the load through the centroid of the cross-sections. Deflections are of particular interest in the case of the square cross-section where they are independent of the orientation of the load and the channel where skew-bending develops when a load is applied at the centroid and in a direction initially parallel to the face of the web.

In Fig. 5 are shown three cantilever beams which illustrate the characteristics

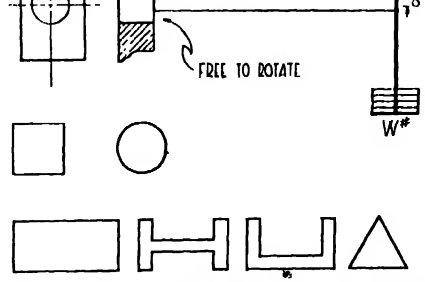


Fig. 4. Beams of different cross sections.

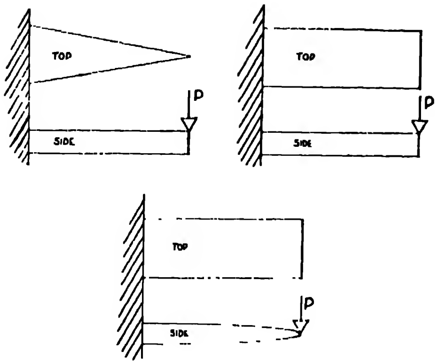


FIG. 5. Beams of variable cross section.

of beams of so-called "constant strength." Several interesting characteristics of these beams may be summarized in the following table in which ratios are expressed.

Type	Maximum Angle	Maximum Deflection	Weight
Prismatical	1	1	1
Wedge (top view)	2	1.5	0.5
Parabolic (side view)	4	2	0.67

A beam composed of two materials, Fig. 6, permits the study of both deflection and stresses. One method of approach is to replace the brass by an "equivalent" amount of steel thus making an inverted T-beam. Compared with a single piece steel beam of the same dimensions as the composite beam, the ratio of the maximum deflection is about 1.65 and the ratio of the maximum stresses is about 2.00.

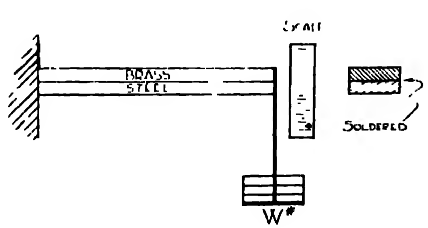


FIG. 6. Beam of two materials.

A simple illustration of combined bending and torsion loading is afforded in the case shown in Fig. 7. Both vertical deflection and angular rotation can be calculated analytically and measured experimentally.

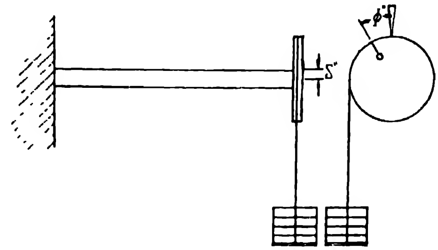


FIG. 7. Combined bending and twist of a shaft.

Mechanical springs of various types are shown in Fig. 8. Separately shown are cases of a system of two helical springs which constitute a statically indeterminate problem, a spiral spring, a power spring in which the material is subject to bending and a Belleville or disc spring. The latter spring illustrates a case of nonlinear load deflection relationship and various interesting characteristics including snap action can be shown when the height or "dish" is made sufficiently great.

The above several examples serve to indicate the type of problems which may be

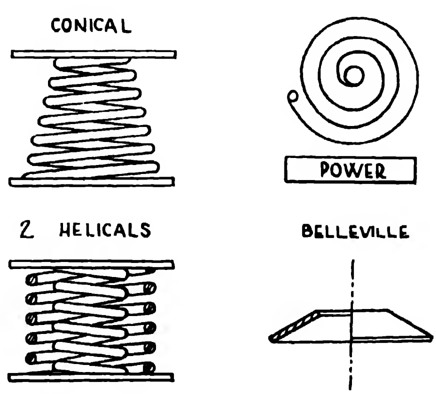


FIG. 8. Various mechanical springs.

profitably treated in a mechanics laboratory course in the principles of elastic properties of materials. It seems advisable to provide the student primarily an opportunity to demonstrate for himself what configuration an elementary engineering member will assume and how it will be stressed under actual loading conditions. The student should also be able to establish a confidence in the formulas he derives in the theory course in Strength of Materials by verifying his calculations by basic experiments.

Student Opinion of Mechanics Laboratory

At the close of a semester, two groups of students in theory classes in Strength of Materials were asked the question: "For your best interest as an engineer, do you believe you should have, in connection with your theory course in Strength of Materials, a mechanics laboratory course in (1) Testing Materials, (2) Principles which parallel the problems in Strength of Materials, or (3) both Testing Materials and Principles?" Their replies were made on paper unsigned.

Subject Matter Chosen	Students No.	Students %
Testing Materials	3	9
Principles	22	65
Testing Materials and Principles	9	26
	34	100

A preponderant number of the students were strongly in favor of a laboratory course in the elementary principles of mechanics. They were decidedly interested in the idea of observing the principles of mechanics by use of such exercises as mentioned above, as shown by the remarks which they volunteered with their indicated choices.

Course Material

As a result of the most recent direct studies which have been made on this subject of what course material should be offered in the mechanics laboratory, it appears that the engineering student should be offered both testing materials and principles of Strength of Materials. This may be accomplished best by separating the two laboratory phases or else it is felt the principles feature will be given too little attention from the teaching standpoint. Without necessitating the introduction of more credit hours than is currently provided in most curricula, it is believed that the instructor in the theory course in Strength of Materials could profitably meet his regular students once each week in a newly equipped room for the purpose of examining models and working problems in the principles of elastic loading of simple mechanics members. The regular testing materials course could be continued without alteration. In such instances where it is found impractical to provide both a session in the principles and one separately in testing materials, it is recommended that the student be given a laboratory course in principles illustrating problems of the type covered in the theory course in Strength of Materials.

Demand for Graduates

A final concluding remark of much broader scope, moreover, is based on a current demand for engineering graduates firmly trained in basic studies of mechanics, physics and mathematics, and an interest shown by some important number of high caliber engineering students in fitting themselves for research, development, design and teaching in the field of mechanics. It is believed that engineering colleges should give consideration to this present problem with a view to establishing an undergraduate curriculum in each school which can justify the training of interested competent students both from the standpoint of job placement and adequate instruction. A bachelors degree such as Bachelor of Science in Mechanics would presumably include the course work now regularly offered all students during the first two years, including introductory courses in the various professional departments such as mechanical, electrical and

civil engineering. A student enrolled in mechanics, however, would be expected to take additional work in mathematics, physics and such courses in mechanics as advanced strength of materials, advanced dynamics and vibration problems, advanced fluid mechanics and such other courses in this field of mechanics which are generally open to graduate students enrolled in other professional departments. It is believed that there exist at the present time various engineering colleges throughout the country which can formulate out of currently offered courses an undergraduate curriculum leading to a bachelors degree in mechanics.

Acknowledgment is gratefully made of the help of Mr. Robert E. Vehn in working up various data and for preparing the drawings.

College Notes

Herbert A. Simon, former Chief of the Management Engineering Branch of E.C.A., will join the **Carnegie Institute of Technology** faculty next fall as Head of the Department of Industrial Administration, President Robert E. Doherty announced.

Paul E. Hemke has been appointed dean of faculty at **Rensselaer Polytechnic Institute**, succeeding Matthew A. Hunter, who has reached the retirement age. Dr. Hemke, head of the Department of Aeronautical Engineering since 1936, was selected by the U. S. Army at the conclusion of World War II to head a scientific mission to England and Europe for the study of captured German documents and equipment in the field of aeronautics. Dr. Hunter, retiring faculty dean, has served in that office since 1944, was formerly head of the departments of metallurgical engineering, electrical engineering and physics, and is well known for his research and consulting work in metallurgy. President L. W. Houston announced that the trustees had also approved two other major appointments. Ray Palmer Baker, dean of students, becomes a vice president of the Institute. He will continue as dean of students, the office to which he was appointed in 1944 after having served as director of Rensselaer's social studies program. John B. Cloke becomes head of the Department of Chemistry. He joined the faculty at R.P.I. in 1917 and is now a professor of organic chemistry.

General Usefulness of the Aeronautical Engineering Curriculum*

By E. F. BRUHN
Head, School of Aeronautics, Purdue University

Introduction. The members of this audience being aeronautical people, are no doubt well satisfied with the general usefulness of the training as provided in the normal aeronautical engineering curriculum. However, there are many teachers and persons in fields of engineering other than aeronautical, who are somewhat skeptical about the general usefulness of the aeronautical engineering curriculum. This skepticism is indicated by the following general statements which the writer frequently hears, namely (1) "The aeronautical engineering curriculum is a highly specialized curriculum." (2) "The aeronautical engineering graduate is not prepared to work in fields of engineering other than the aviation industry." (3) "We have no jobs suitable for aeronautical engineers in our company."

The writer does not question the sincerity of the persons expressing these opinions; however, he feels they are incorrect because the true facts are not known or realized by the individuals making these statements. Thus the purpose of this brief paper is to bring out certain general facts which should tend to eliminate such opinions as quoted above.

One might say, "Why be concerned with such statements as listed above?" The writer is concerned because such opinions by persons in non-aeronautical industries can cause unnecessary hardships or difficulties to aeronautical students on graduation or in later years. For example, circumstances often arise such as domestic problems, health, etc., which dictate or require a person to live in a region where there are no aeronautical industries, and since the airplane manufacturing industry is concentrated in several sections of the United States, these circumstances can often arise. Furthermore, such statements as listed above tend to discourage young men from studying aeronautical engineering even though their interests lie in the aeronautical field.

Since the writer is a graduate from a civil engineering curriculum and spent a number of years in practical civil structural and mechanical design, before entering the airplane industry, he cannot be accused of not being familiar with curricula other than aeronautical engineering, or with practical industrial experience in other engineering fields.

The Airplane Is a Highly Technical and Scientific Machine

In 1903, the Wright Brothers proved that man could design and build a heavier than air machine that could take off from the earth's surface, be controlled in the air and returned safely to the ground. Once it was established that a machine called the airplane could fly, the next step which naturally follows is to develop that machine so it will do useful work in the form of satisfying certain specifications. The performance specifications for the first experimental airplane

* Presented at a Conference of the Aeronautical Engineering Division at the Annual Meeting, Austin, Texas, June 15, 1948.

to be contracted for by the Army specified that the airplane must carry one person a distance of 70 miles at a horizontal speed of not less than 40 miles per hour. Since the airplane is an airborne vehicle, it is evident that to design such a machine to satisfy such a specification, some knowledge of the principles of airflow past moving bodies in the atmosphere would be necessary. The demand for engineers with this knowledge led to the development of college courses both theoretical and experimental which dealt with the subject of air forces on the airplane, or units of the airplane, and thus the field of aerodynamics was born. The first students graduating from these new courses were no doubt referred to as aeronautical engineers since they possessed a certain knowledge in this new engineering science called aerodynamics.

For many years the airplane was a rather simple machine from a structural and power plant standpoint but as the demands for the airplane increased, particularly the demands of war, the airplane of today has developed into a highly scientific machine, and as a result, a rather extended series of academic courses have been developed dealing with the knowledge which is basic for the development and design of the airplane. Thus it is true that the aeronautical engineering curriculum as now provided by most leading universities is primarily concerned with providing a complete fundamental and applied training toward the development, design, production, and operation of the machine called the airplane; however, a study of the modern military or commercial airplane of today indicates the following facts:

(1) The airplane is a machine which requires a thorough understanding of the basic principles of fluid mechanics, thermodynamics, and aerodynamics, since the application of these principles is necessary in determining the proper external configurations of the airplane to satisfy a given performance specification.

(2) The airplane is a machine in which many of the best structural materials are used, as for example, alloy steels, aluminum alloys, and magnesium alloys. Practically every type of production machine tool is used in producing the airplane and the accuracy of fabrication and assembly methods is highly developed in this field since safety and long life of the airplane parts are paramount requirements.

(3) It is a machine that has a power plant which demands the highest degree of understanding of engineering fundamentals and the properties of materials to insure the successful development, design, and installation of the power plant.

(4) The airplane is a machine that possesses a number of different types of engineering installations, all of which require a thorough understanding of the engineering fundamentals and their application to insure their proper and reliable operation in the airplane. To mention a few installations, we have various mechanical, hydraulic, and electrical control systems; heating, ventilating, and pressurizing systems; fuel and oil systems, and all kinds of interior fixed equipment, all of which must be designed.

The General Make-Up of the Aeronautical Engineering Curriculum

The first five semesters of the regular eight semester curriculum in aeronautical engineering are very little different from the usual curriculum in mechanical or civil engineering. This is the period in the curriculum where basic education in the engineering sciences is given together with the necessary mathematical knowledge. Thus the aeronautical curriculum requires chemistry, physics, statics, dynamics, strength of materials, fluid mechanics, thermodynamics, and basic elements of electricity. In mathematics, the aeronautical engineering curriculum usually requires one or two courses beyond the sophomore calculus and thus, generally speaking, the aeronautical curriculum requires more mathematics. Cer-

tainly this additional requirement in mathematics can be no criticism of the aeronautical engineer, since more training in mathematics should mean more and better tools to better understand and apply the fundamentals of engineering.

It is customary for other engineering curricula to require certain shop and drawing courses during the first five semesters. The aeronautical curriculum likewise requires such courses. It is true that in shop courses such as welding, machine shop, sheet metal shop, etc., certain emphasis is placed on airplane materials and airplane fabrication requirements, and likewise in any engine shop course the emphasis is placed on the study of the airplane power plant, but since the airplane is a highly technical machine, any study of the various units that go to make up the airplane, the materials they are made of, and the methods of fabrication and assembly, certainly do not tend to lower a student's basic training in this general field of instruction.

The last three terms of the aeronautical engineering curriculum are chiefly concerned with directing and expanding the principles and fundamentals of engineering science toward the problems involved in the development and design of the airplane. This phase of instruction can be divided roughly into three distinct series of courses, one in the field called aerodynamics, one in the field of structures, and one in the field of propulsion or power units.

Aerodynamics is a subject which is concerned with determining the performance, stability, and control of the airplane. To determine these factors a complete understanding of the magnitude and distribution of the air forces on the airplane is necessary, thus the aeronautical engineer must have a very good understanding of the fundamentals as studied in dynamics, fluid mechanics, and thermodynamics if he is to obtain a thorough understanding of the subject of aerodynamics. Because the airplane is an airborne vehicle, safety of operation must be insured, hence the loads on the airplane are possibly more scientifically calculated than for most machines or structures in other fields of engineering.

Since the airplane is an airborne machine requiring a relatively high speed to maintain it in the airborne condition, there are two major structural design requirements which must be satisfied: (1) Safety, which means that all structural units must be strong enough to carry the loads and to operate satisfactorily since failure in strength or in operation would, in many cases, cause loss of the airplane together with human lives. (2) Minimum structural weight, because every pound of airplane structural weight which is not absolutely needed decreases the pay load at least that much. To obtain a load carrying efficiency to make air transportation possible from an economic standpoint, the large factors of safety (sometimes referred to as factors of ignorance) that are used in many other fields of structural design such as buildings, machine tools, etc., are not permissible in airplane design since such large factors would render the airplane inefficient as a load carrying vehicle. Thus safety with light weight and reliability of operation demands structural designers with a thorough knowledge of the physical properties of materials and their use, not only in the so-called elastic theory of structures which forms the basis of structural design in most other fields of structures, but also in the theory of plasticity, since design of airplanes is made on both a yield and an ultimate strength basis.

The aeronautical engineering curriculum includes a series of courses dealing with materials and the theory of structural analysis. These fundamentals are then applied in the structural analysis and design of the airplane. The structure of the modern airplane presents many types of structural units, thus the student obtains a broad training in basic or elementary design such as tension members, columns, various types of beams and beam columns; all kinds of

fittings and connections involving bolts, rivets, welding, spot welding, gluing, etc. Due to the requirements of light weight, low overall aerodynamic drag of the airplane, and also due to the fact that the wing and body are subjected to bending and torsional loads simultaneously, a new type of stressed skin-cellular structure has been developed for airplanes. This new type of structure is being gradually considered and used in other fields of structure such as the railway car and the automobile body. Thus relative to structural training and education, the writer feels that the aeronautical engineering graduate is as well prepared, if not better prepared, than the graduates from other curricula emphasizing structures such as civil and mechanical engineering.

Obviously the airplane cannot be tested in the air to determine major structural weaknesses or the faulty operation of major installations, since such weaknesses or faulty operation might cause the loss of the airplane. Therefore, the aeronautical engineer, regardless of the extent and thoroughness of his theoretical investigations, must carry out a great deal of laboratory testing to verify his theoretical results in order to insure the safety of the airplane on its initial test flights. The aeronautical curriculum therefore provides laboratory courses involving the static and dynamic strength testing of the airplane and its component parts, vibration tests and many other tests too numerous to mention.

Likewise to insure the results of the theoretical aerodynamic calculations, the aeronautical engineer must carry on a great deal of laboratory testing in the field of fluid dynamics and aerodynamics, particularly in the form of wind tunnel teaching. All of these aeronautical laboratories involve the use of the latest type of measurement instrumentation both mechanical and electrônic, and no aeronautical graduate can be logically criticized for possessing this experience in using the highest type measurement instrumentation.

During the senior year of most engineering curricula, an attempt is made to introduce the student to the field of product design. Thus the mechanical engineering curriculum provides a course or two in machine design, the civil curriculum a course in building design, or bridge design. Likewise, the aeronautical curriculum usually provides one or two design courses, one usually dealing with the aerodynamic layout of the airplane to satisfy a given performance specification plus a study to determine the general structural layout or design for the same airplane. The second course in design usually concerns itself with the engineering study or layout of one or more of the airplane installations such as the surface control system, the hydraulic system, the air conditioning system, etc.

The airplane has certain rather difficult design requirements which are not present to such a great extent in other fields of design. These are: (1) light weight for every unit in the airplane; (2) compactness in design, because the over-all dimensions of the airplane must be as small as possible, which in turn means that all installations must occupy limited spaces. This fact requires a great deal of accurate layout and constant consideration of the design requirements of all installations since the final over-all arrangement of the various installations involves many compromises; (3) safety which means that every unit of the many installations must operate successfully on the initial trial flight of the airplane, and (4) economy of fabrication and assembly, a requirement which is present in product design in all fields of engineering.

The aeronautical engineering student in his design courses faces requirements which work against rule of thumb methods or empirical methods of design. One installation cannot be designed properly without considering the problems involved in the layout of other installations, thus the aeronautical student obtains a broad introduction to the field of product design. In the writer's opinion, the design

work in the aeronautical curriculum is no more specialized than other engineering curricula that direct the efforts toward the design of machines other than the airplane.

The aeronautical engineering curriculum provides a series of courses both theoretical and laboratory which are concerned with the power plant of the airplane. The aerodynamic design of the airplane cannot be made without a thorough fundamental understanding of the performance characteristics of the various types of power plants used in airplanes. The installation of the power plant to make it work successfully, on or in the airplane, is a job which is done in the engineering department of an airplane company. It is a job that requires a thorough understanding of the principles of thermodynamics, fluid mechanics, heat transfer, and internal aerodynamics. The aeronautical engineering curriculum concerns itself with these installation problems, particularly the principles involved.

It is true that the laboratory work in the power plant field is confined chiefly to the aircraft power plant field; however, it should be realized that the aircraft reciprocating gas engine and more recently, the gas turbine, represent power machines which comparatively speaking are highly technical and require the use of the finest instrumentation in their engineering testing. It would appear reasonable to assume that aeronautical engineering students trained on such power plant equipment or machines should be able to easily adapt themselves to the testing and installation of power plants in other fields of engineering which in general are somewhat less technical or scientific.

In conclusion, summarizing the general purpose of this paper, the writer sincerely believes that upon persons in the aeronautical teaching field, falls most of the responsibility of seeing that persons in non-aeronautical industries, with opinions as listed at the beginning of this paper, are acquainted with the true facts regarding an aeronautical education. The writer on several occasions has contacted representatives of large non-aeronautical companies who were interviewing students on the campus regarding jobs and questioned them as to the reason they did not interview aeronautical students. Their answers showed amazing ignorance regarding the training of an aeronautical engineer. They were most interested in the facts and expressed the intention of acquainting their superiors with the true facts. The writer suggests that we in the aeronautical teaching profession, expand these contacts with people in the non-aeronautical industries.

Selection of Applicants for Admission to Engineering Schools*

By WILEY THOMAS, JR.
Assistant Co-ordinator, College of Engineering, University of Tennessee

One of the greatest problems facing almost all Engineering Colleges today is the proper selection of applicants for admission. Entrance requirements based on performance in high school, plus compulsory or voluntary testing programs, may be the answer if they can be combined with competent counseling at the high school level. Can competent counseling be provided when we have some thirty-five thousand high schools scattered over three million square miles? I believe it can be very closely approached if we, of all people, apply machine age techniques. I would like to suggest that all of the engineering schools in the United States cooperate through an appointed committee to foster the production of a documentary motion picture directed to high school students and covering, among many other items, the following:

1. What do engineers do?

   This is one of the first questions many students ask an advisor.
   The film should not emphasize the romantic aspects of completed engineering achievements, but should deal with the specific day-to-day tasks performed by engineers.
2. What type or types of individuals are most likely to succeed in the engineering profession?
3. How can I tell whether or not I have the necessary aptitudes and qualifications?

   An explanation of the standard testing programs should be given explaining the desirability of participation in testing programs and pointing out the significance which should be given to the results.
4. What is the difference between a Vocational School, a Technical Institute and an Engineering School or College? How can I best determine which I should attend?
5. Would it help me to talk to practicing engineers in this location? If so, how should I approach them? In what specific way could they assist me?
6. How much does an engineering education cost?
7. What courses of study should I take in high school? Are any of the subjects more important than others?
8. When should I make application for admission?

These questions are only a few of those which should be answered. I, of course, do not mean by listing questions that the film would be broken up into questions and answers, but rather that this information would be woven into an attractive pattern that would interest students, teachers, parents, and even the general public. Only that information which is common to all engineering schools would be included in the film. Specific information relating to individual institutions would be included in supplementary written material.

How would such a film be used?

To take a quick example: In the State of Tennessee the film would be routed each year through all high schools in the state along with specific instructions for

* Paper presented before the Southeastern Section of the A.S.E.E., Gainesville, Florida, March 4, 1948.

presentation and supplementary written material covering the location of testing centers, entrance requirements for all Engineering Schools in the State, etc. The administration of the program could be handled by the College of Engineering of the State university.

How much would a film of this type cost and who would pay for it?

Since I do not have in mind the customarily simple type of vocational guidance films which generally run $10,000 or less, I would roughly estimate the cost at $80,000 to $200,000. A lot of money, yes! But with only 100 of the 135 accredited engineering colleges in this country participating to the extent of $2000 each, it certainly is not impossible. I am afraid that every Engineering School in this country spends considerably more each year on unqualified students who drift into our schools because of little or no guidance. This is not the only way a film of this type could be financed; it appears to me, however, to be the most desirable.

Could the same result be obtained in other ways?

The technical societies along with the local high school guidance officers have done an outstanding job in some of the larger cities, but what about the hundreds of students in each state who come from the smaller communities? We have toyed with the idea of taking our story to the State teachers' meetings, feeling that by training the high school principals, mathematics and science teachers and guidance officers, we might promote more effective guidance. These are only a few of the possible alternatives and should be utilized and encouraged to the fullest extent, whether or not films are made available.

In closing, I thought you would be interested in knowing what we have in mind with regard to selection at the University of Tennessee. This is our very *tentative* plan:

1. Study the effectiveness of present entrance requirements; eliminate those found to be unnecessary; and see that those which remain are enforced.
2. Promote the use of the Pre-Engineering Inventory. Make it generally available throughout the State. Four testing centers are now open.
3. Urge more and better guidance in the high schools. The film I mentioned is only one of the many possibilities for doing this.
4. Have the records sent to our admissions officer long before the student leaves home for freshman week. Examine the records and admit the good prospects. For those who are doubtful, require them to show aptitude for engineering by taking at least one quarter of remedial subject matter, including a specially designed course in elementary mathematics and possibly similar courses in physics and chemistry. Let the doubtful student show aptitude in these subjects before he is allowed to enter as an engineering freshman. This will delay the doubtful student one quarter, but it may result in a real gain.
5. Improve the quality of guidance within the Engineering College. The job is too important to be handled as a routine matter.
6. Because applicants may at some time in the future greatly exceed our capacity, we propose to determine now the true effectiveness of the testing procedures so that, if it becomes necessary, a system of admission through selective testing can be sold to the Board of Trustees and citizens of the State.

By such a plan, no one would be denied entrance into the State school.

This is our tentative plan. It is based upon the conviction that only through a combination of testing and effective counseling, both in high school and throughout the college program, plus the effective use of constructive propaganda, can we approach our responsibilities to the students, the citizens of our State, and to the industries of our community.

What is the Optimum Load for a Coordinator?*

By H. R. BINTZER

Drexel Institute of Technology

This attempt to find an answer to the question that serves as a title to this report has left your reporter with a conviction that he feels compelled to state with the full knowledge that in doing so, he is violating the basic tenets of objective reporting.

The conviction is this—apparently most of us coordinators are guilty of either:

(1) relatively inadequate record keeping of our activities as coordinator; or
(2) a socially laudable but unbusinesslike inclination to be unduly modest about our activities.

In any event, the responses to our questionnaire were in too many instances somewhat evasive and incomplete. However, analyzed in their composite, we feel that we are now in a relatively good position to draw a word picture of a coordinator and his duties.

Before going into the specifics of this report, we should like to state that our questionnaire assumed certain basic functions of any and all coordinators; the questions contained therein are admittedly "leading" ones, but they were constructed so, deliberately, in order to prevent the development of a pet or unique theme by any one college in its reply. As much as possible, your reporter attempted to phrase his question in such a way that the replies thereto could be reduced to a number—or at most to a very short sentence of explanation.

The mailing list of the Cooperative Engineering Educational Division of the ASEE was used in contacting the 33 colleges to whom our questionnaire was sent. Only four colleges failed to reply to our letter; of the 29 who did reply, 12 had no contribution to make, leaving 17 colleges whose statements and figures form the basis of this report.

Before proceeding further, it might be well now to review rapidly the 14 questions that were asked in our questionnaire. They are:

(a) How many co-ops do you place on an average in any one placement period? (Normal times—discount war years.)

(b) How many full-time Coordinators do you have? How many part-time Coordinators?

(c) How many persons on your clerical staff?

(d) Is your office responsible for any other key administrative function? (Such as admissions, graduate placement, etc.)

(e) Do your Coordinators teach any classes, either in connection with cooperative work, or otherwise? To what extent?

(f) How many co-op placements do you maintain beyond a twenty mile limit of your college?

(g) In your opinion, what is the maximum number of co-ops for whom each Coordinator should be responsible?

(h) How often do your Coordinators visit students "on-the-job"? Are students who are locally placed visited more often, less often, or the same number of times as those more distantly placed?

* Presented before the Division of Cooperative Engineering Education at the Annual Meeting, Austin, Texas, June 14, 1948.

(i) What percentage of your total cooperating companies are visited each placement period by your Coordinators?

(j) What is the average number of companies that each of your Coordinators contacts over the space of a *year* to effect the necessary co-op placements?

(k) When on trips away from the campus, does one coordinator undertake to handle *all* co-op placements in that area, or do each of your coordinators at all times handle only their own co-ops even though this latter might mean two or more of your Coordinators in the same area at the same time?

(l) What methods do your Coordinators use to keep abreast of personnel changes in cooperating companies? (That is, those changes that might effect co-op placements in that company.)

(m) Are your Coordinators called upon to aid your Public Relations program by addressing high schools, service organizations, etc.—or by any other similar services?

(n) In your opinion, will your Coordinators have to spend more or less time in the future in "selling" the co-op idea? Why?

With this introduction then, let us go into the specifics of the report.

The first significant information, perhaps, is that concerning the *average* number of co-ops placed by any *one* coordinator during any *one* placement period. It was found that this figure ranged from a low of 8 to a high of 250 students per coordinator with the average being *59*, and the modal figure 50. On the other hand of the *9* colleges that place 100 or more co-ops each placement period, the average is 83 students per coordinator even though the modal figure is again 50.

This average of 83 compares very favorably with the figure of 100 which was given by almost all of the colleges in answer to the question "In your opinion, what is the maximum number of co-ops for whom each Coordinator should be responsible (in any one placement period)?" It appears obvious to this reporter that almost all co-op colleges are pointing towards greater individual attention to each co-op and cooperating companies induced in part, no doubt, by the trend toward placements being conducted on the basis of integrated training programs rather than "so-called" term to term spot placements—hence, the emphasis on no more than *100* co-ops per coordinator in any one placement period.

Another figure of interest is the one showing the coordinator—clerical or secretary relationship. Ten colleges reported their operations in this respect on a 1 to 1 basis; six were on a 2 to 1 basis, and one college reported no clerical staff in the co-op office whatsoever.

In answer to the questions concerning other key administrative functions (such as admissions, graduate placement, etc.) lodged in the co-op office—eight reported responsibility for one such function; three had responsibility for two such functions, while one college admitted to five. Six colleges reported that they had no such responsibility at all. Interestingly enough, four colleges reported that the function of "admissions" is lodged with their coordinators, and seven colleges place their graduate placement in the co-op office. It was found, too, that ten colleges require some form of teaching duties of their coordinators, while seven do not. As might be expected also, 14 of the 17 colleges stated that their coordinators are expected to lend their services to the Public Relations Office chiefly for the purpose of making addresses to high schools, service organizations, trade associations, and the like.

Most of the information given in the foregoing concerns the "resident" or internal activities of the coordinator. But what of his activities abroad; those activities which take him beyond the confines of his office? Well, the following may shed some light on this question.

You will recall that we found 50 to 83 co-ops (on the average) being placed by each coordinator each placement period. However, these figures take on added

significance when it is found that ten colleges reported that their coordinators visit each of their co-ops "on-the-job" each term; six said they made such visits every other term, while one said they visited only if trouble arose on the job. On the basis of a 4-term year, then, each of the coordinators in ten of these colleges makes 200 to 332 "man-job" visitations. On the basis of the ideal 100 co-ops per coordinator per term, this same 4-term year would result in 400 man-job visitations per year! However, on trips of more than one day away from the campus, and in the interests of economy, it seems to be the general practice for *one* coordinator to make all company and co-op placements in that area regardless of usual coordinator assignment.

Further, it was found that the number of companies contacted in any one year by one coordinator to effect his placements varied from a minimum of two to a maximum of 300 with two colleges reporting this latter figure. The figures that make this information meaningful from a workload standpoint, however, are those which reveal that in eight instances each coordinator visits all of his companies each placement period; two make such visits three out of four placement periods, while five visit their companies half the time or less. Two colleges gave no information on this subject at all.

From all of the foregoing, then, it would seem that the typical coordinator should expect to be responsible for 83 to 100 co-ops each placement period, have the use of a full-time secretary, expect to do some teaching and some Public Relations work, assist in at least one other key administration function, visit each of his co-ops each term, and maintain good relationships with 100 to 150 employers throughout the year.

Is that then the "optimum load" for a coordinator? Well, the last question on our questionnaire, namely: "In your opinion, will your coordinators have to spend more or less time in the future in 'selling' the co-op idea?" may give some clue to the answer to that question.

Thirteen colleges said they expected less trouble "selling" the co-op idea in the future; four said they expected more trouble. All, however, paid some heed to the possibility of an economic break which will make the securing of jobs more difficult even though the employer may be sold on the co-op philosophy.

It is indeed encouraging to note that opinion is almost unanimous in the belief that industry is becoming more and more cordial to the co-op idea. Let us hope that our college administrations will be even more enthusiastic, and not assign so many duties to our coordinators that they find it difficult to discharge their fundamental responsibility of co-op training.

Sanitary Engineering Careers

By KENNETH W. COSENS
Assistant Professor of Civil Engineering, University of Texas

The engineering student of today is usually requested to make a decision at the end of his freshman year as to the branch of engineering which he expects to pursue, be it mechanical, chemical, civil, electrical, etc. At the end of his sophomore year he usually further indicates his field of specialization in the chosen branch. If he wishes to be a civil engineer, he chooses at the beginning of the junior year whether he wishes to specialize in structures, highways, hydraulics, railroads, sanitary or possibly others.

If the choice of the young engineer happens to be in the field of sanitation it is especially important that this choice be made at the beginning of the junior year, else valuable time will be lost and extra school time in excess of the four years will be necessary to complete the degree requirements. The sanitary option requires that work in chemistry and bacteriology be completed before graduation so it must be started early in the junior year. In many of the engineering schools, most civil engineers have no contact with the staff members who are teaching the sanitary engineering subjects until the senior year. They have had little chance previous to this time to see whether or not they are interested in sanitary engineering. It is at this time that senior engineering students indicate that they have become very interested in sanitary engineering, but obviously it is too late to pursue the program leading to the B.S. degree under the sanitary option.

The question may logically be asked, "What is a sanitary engineer?" The National Research Council committee on sanitary engineering in 1943 published the following definition: "A sanitary engineer is one who by suitable specialized training, study and experience has fitted himself to conceive, design, direct and manage engineering works and projects developed as a whole, or in part, for the protection and promotion of the public health and to investigate and correct engineering works and projects that are capable of injury to the public health by being or becoming faulty in conception, design, direction or management."

So the student engineer may have some information available telling him of the work which rightfully lies within the scope of the sanitary engineering graduate, the following information is given.

Fields of Service

There are several types of work for which the graduate sanitary engineer will find himself especially well prepared. Seven of the most logical classifications are given here.

1. Municipal

Many positions are available for sanitary engineers in the employ of cities, counties, or other municipalities in the capacity of design and detail men on sanitary works. Often a city engineering department requires a man to do work on plans for sewers, water mains, water and sewage plants, pavements, curb and gutter work and plans for other municipal functions. No engineer is better equipped for this work than the sanitary engineer.

The collection and disposal of municipal refuse is a rather complicated and important problem of municipalities which require a well-trained sanitary engineer to direct. With proper organization and direction, municipal refuse can be made to yield surprisingly large revenue.

Members of municipal engineering staffs are employed because of their ex-

perience and ability and usually hold their positions through several changes in administrative officers. Any one of these jobs may well lead to city engineer or city manager positions.

2. Public Health

There are three logical areas of employment within the public health field. Jobs are available in city and county health units, state health departments and the U. S. Public Health Service. Work in all of these may be quite similar. There is a tendency for sanitary engineers to start in the smaller city and county health departments, gain well earned experience and then advance to the more responsible positions in the large city departments or to the state or federal agencies. The state departments and the U. S. Public Health Service do a great deal of basic research and investigation work into the problems of public health engineering. This work requires specially trained technical staffs on which the engineer has a prominent position. There are new fields of development in the control of atmospheric pollution, stream pollution control, insect and rodent control and new industrial waste fields. Every time a new industry develops or a new process is perfected, new problems confront the public health engineer. Then too there are the traditional problems of water supply and sewage disposal. The solution of most of these public health problems require the cooperative services of the medical men, the dentists, nurses, engineers of all kinds, the chemists and the bacteriologists. It is an especially interesting field of work, one that challenges the knowledge and ingenuity of those who choose it.

Salaries and promotions are variable from one organization to another, from one part of the country to another, but are limited only by the ability and ambition of the individual.

3. Operational

It is at once apparent that industrial waste treatment, sewage treatment and water treatment plants will require highly trained personnel for operation and supervision. This field of work is rapidly expanding and employment opportunities are available from industry and municipalities. Any young engineer will find himself with inadequate training for any one of these operational jobs but that is the challenge which makes the job interesting. He must do a large amount of self training, on the job, to execute properly the responsibilities of operation.

4. Industrial

Reference is here made to those positions, in most industrial concerns, where the services of an engineer are needed to aid in producing or controlling an environment for better working conditions. In this capacity the engineer is usually called an industrial hygienist. Great strides have been made recently by industry in improving working conditions, and the industrial hygienist has been largely responsible for these advancements.

Sanitary engineers have the background and training needed to function in this very interesting field of work. The work involves a study of the causes and control of industrial hazards. Many interesting problems involving statistical data, medical information, engineering skill and human psychology will confront the person choosing this type of work. Salary and advancement opportunities are especially good.

5. Private Consulting

One of the most interesting and most varied of the fields of employment is the position with a consulting engineering firm. As more people in this country congregate in cities causing concentrated centers of population more work in the consulting sanitary engineering field will develop. Every municipality will need a water treatment plant, a sewage disposal plant or a garbage incinerator plant. Industries need waste disposal plants. These treatment plants must be designed by sanitary engineers in cooperation with mechanical, chemical and electrical engi-

neers. This field of work is relatively new, it is a developing field, one that will employ many more engineers as time goes on and our country becomes more thickly populated.

This work leads to the ownership of the consulting engineering firm, a position which taxes the administrative as well as the business and technical skill of the engineer. It is one of the best paid fields of engineering endeavor. A tremendous pride and satisfaction is realized by successful operation of a consulting firm.

6. Teaching and Research

These two types of work are placed together although an individual may pursue either entirely independent of the other. Some college and university staff members may do research only, others only teach. Considerable research is done by private industry and government agencies.

Teaching is a profession which has many opportunities for the sanitary engineer. It may be pursued by a person interested in any of the following phases of sanitary work: Design or operation of water, sewage or industrial waste treatment plants, sanitary chemistry, bacteriology, zoology or the many phases of public health work. Usually the teacher has ample opportunity to work in all phases of the work, perhaps specializing and doing research in one phase only.

Research is a very interesting type of work for those people who enjoy approaching a problem unbiased in thought about its outcome, who are willing to work hard to find out all there is to know about something and who are properly educated. Not all people are research minded and one should cautiously choose this as a field of work unless he is positive he will enjoy the work. There will always be marvelous fields of exploration on scientific frontiers that are awaiting the competent research man.

7. Sales

Sales work in the field of sanitation is basically no different from sales work in any engineering field. The engineer salesman must be able to meet his client with ease and confidence, must be especially well prepared to answer difficult technical questions about his product and must be willing to travel as required by the specific job he accepts. The work is interesting, offers many challenges to the engineer's ingenuity and training and is usually very well paid. Engineering sales work is not of the house-to-house variety. Usually the client calls in the sales representative to discuss a product or process; this may be the first contact between salesman and client. A good salesman need never be out of a well-paid job.

In General

The sanitary engineering graduate may find that his first job is not in the field of sanitation. If so he probably is not too handicapped as he has had considerable structures, surveying, highways and hydraulics besides a good basic background in chemistry and bacteriology. With a sanitary engineering background there are many fields of work he might pursue, in which he is in no way handicapped. An interesting variety of jobs are available for young men in the field of sanitation.

Where to Get Information

Any young man may receive excellent information from engineers who have had considerable experience in the various fields. Consult them frequently for guidance. Engineering faculty members are always glad to help a student weigh the possibilities of a chosen field and give information to those who are deciding about courses of study in undergraduate engineering. Considerable information is available in the college and university catalogues.

When the undergraduate engineer is making these decisions some thought should be given to graduate work leading to the master's and doctor's degree. More and more emphasis is being placed upon advanced work in all branches of the pure and applied sciences, the latter including our profession, engineering.

The Case for the Sluggers

By R. C. BINDER

Professor of Mechanical Engineering, Purdue University

Frequently questions arise about the selection of units for force and mass. In the recent literature dealing with the flow of fluids there is a tendency to use the pound as a unit of force and the slug as a unit of mass. The following discussion brings out the main reasons for this trend. Some features of this trend may be of interest to teachers and industrial men.

The basic dynamic equation states that force equals mass times acceleration. The units for acceleration have been well established for some time. The remaining questions concern the units for mass and force. The selection of units is arbitrary. Any set of arbitrary, consistent units could be followed. Some units, however, have certain advantages, and tend to reduce possible confusion.

As an example, one could select the "pound-mass" as a unit of mass and the "pound-force" as a unit of force. This set of units is perfectly all right if it is used consistently, and is made clear to the reader. In calculations, however, one might forget the second part of the compound word, and then there would be confusion as to just what "pound" meant.

As another example, one could use the "pound" as a unit of mass and the "poundal" as a unit of force, or vice versa. Each combination is perfectly all right if used consistently. Sometimes, however, confusion develops because the two words are similar in spelling and sound.

The combination of "pound" as a unit of force and "slug" as a unit of mass has certain advantages. A force of one pound acting on a body with a mass of one slug would accelerate the body by an amount of one foot per second each second. The two words "pound" and "slug" are entirely different, in both spelling and sound; this tends to reduce confusion. The word "slug" can be considered as the shortened form of "sluggishness," which means inertia. Thus "slug" has the implication of inertia or mass, and thus there is no confusion with force. Also, "slug" is a short word. It is distinctive because it does not have any other common use which would cloud its meaning.

Origin of the Slug

The selection of the word "slug" is somewhat analogous to the selection of the word "enthalpy" for a certain combination of thermodynamic terms. Prior to the adoption of enthalpy, this particular combination of terms was commonly called "heat content." The word "heat content," however, was confusing with other, different terms as "heat" and "heat transfer." Thus the use of enthalpy avoids confusions. The use of the word slug avoids similar confusions.

Let g represent gravitational acceleration. Then the mass of a body is its weight (a force) divided by g. Some advocate the use of the ratio "weight/g" by itself without any special name. This practice is perfectly all right. In some fluid flow studies, however, the equations may have a large number of terms and may be complicated. In such cases a

single term for the ratio of two terms has some value as a convenience; the equation will have a simpler form.

Sometimes these questions are raised: Is it necessary to draw a fine distinction between force and mass, and is it necessary to keep careful note of g? Answers to these questions depend upon the particular applications involved. In some cases it is not necessary to draw any distinction between force and mass. Examples are cases involving static equilibrium, and non-flow process, and cases in which velocity changes and thus dynamic actions are not involved. In many fluid flow problems, however, there is a velocity change, there is a dynamic action, and it is necessary to distinguish between force and mass. In some tract and philosophical studies it may not be necessary to be concerned about any conversion factors, as g and the perfect gas constant. In many engineering calculations, however, the magnitude of the answer is an important feature, and it is important throughout the study to be accurate and careful in dealing with all conversion factors as g.

Sometimes confusion arises as to the meaning of the terms density, specific weight, and specific volume. Confusion can be avoided by using a distinctive and consistent combination of units and terms. Consider the pound as a unit of force and the slug as a unit of mass. Specific weight will be defined as weight per unit volume. Thus water at a certain temperature and pressure has a specific weight of 62.42 pounds per cubic foot. Density will be defined as mass per unit volume. Thus, if g is 32.174 feet per second per second, then the density of the water is 62.42/32.174 or 1.94 slugs per cubic foot. Specific volume is defined as volume per unit weight, as cubic feet per pound.

Short Cuts in Engineering Mathematics

By JOHN B. THRELFALL
Instructor, University of Wisconsin

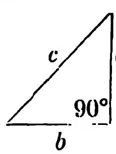
Many times in making up problems for engineering students it is desirable to use slopes or triangles such that not only are the legs in the ratio of whole numbers but also the hypotenuse, the commonest example being the 3–4–5 triangle. It is evident that the use of such proportions eliminates some slide rule work and generally makes calculations much easier, an important factor when one considers that most engineering problems are to test the students knowledge of some subject other than arithmetic or use of the slide rule.

An easy way to get such proportions is as follows:

Take any two numbers x and y where one is odd, the other even and neither is a multiple of the other except when one of the numbers is unity (1).

Let x be the larger; then

$$a = x^2 - y^2,$$
$$b = 2xy,$$
$$c = x^2 + y^2.$$



x	y	a	b	c
2	1	3	4	5
4	1	15	8	17
6	1	35	12	37
3	2	5	12	13
5	2	21	20	29
7	2	45	28	53
4	3	7	24	25
8	3	55	48	73
5	4	9	40	41
7	4	33	56	65
6	5	11	60	61

Particularly convenient proportions are obtained when $x - y = 1$, in which cases

$$a = x + y = 2y + 1,$$
$$b = 2xy = 2y^2 + 2y,$$
$$c = x^2 + y^2 = 2y^2 + 2y + 1,$$

or

$$\begin{cases} a \text{ is an odd number,} \\ c = b + 1, \\ a^2 = b + c = 2b + 1, \\ b = (a^2 - 1)/2. \end{cases}$$

With this limiting condition the following table is very easily set up

a	b	c	
3	4	5	
5	12	13	These values are of course in-
7	24	25	cluded in the general table.
9	40	41	

These relationships might also be of value to the engineer designing trusses, etc., because by using such slopes, the dimensions of the parts on the slope would have rational values.

An old short cut in mental arithmetic which the author uses to advantage almost daily in classroom work is the extraction of square roots mentally. To get the square root of any number, take the nearest whole square root plus or minus the difference of the original number and the root squared divided by twice the whole root. For example:

$$\sqrt{28} = 5 + \frac{3}{2 \times 5} = 5.3,$$

$$\sqrt{60} = 8 - \frac{4}{2 \times 8} = 7.75.$$

The values thus obtained will always be slightly high but they are usually well within 1% which is satisfactory for most class room problems if not most engineering problems. The theory behind this is as follows:

$$\sqrt{N} = a + b$$
$$= \sqrt{(a + b)^2} = \sqrt{a^2 + 2ab + b^2}.$$

Where N is the number whose square root is sought and a and b are two numbers whose sum is $\sqrt{N}$ (the value sought). Now if b is small compared to a, then b^2 is even smaller and could be ignored in the expansion without appreciably affecting the value. Then if a is assumed (the nearest whole square root) and $2ab = N - a^2$ (dropping b^2), b can easily be determined.

$$b = \frac{N - a^2}{2a}.$$

Then $\sqrt{N} = a + b$.

The result, $a + b$, is actually $\sqrt{N + b^2}$ which is only slightly more than $\sqrt{N}$ since b^2 is very small. Since the value from which the root is extracted is always larger by b^2 than the given number, the root is always a bit larger than the true value desired, so in changing the root from the fractional to decimal form, it can often be reduced slightly to come closer to the true value. Thus, anyone can extract square roots mentally and with a few minutes practice be getting the answers as fast as one can write them down.

THE T-SQUARE PAGE

Devoted to the Interests
of Engineering Drawing

W. J. Luzadder, *Editor*
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Engineering Judgment—an Aid in Developing It

Judgment may be defined as that ability to make decisions supporting comparisons and discriminations of observations and facts. Does the development of this ability in the engineering student merit sufficient importance to propose it as a point of emphasis in our engineering curricula, and if so, by what means, and to what extent? Many engineering educators agree that it is of great importance, although in the conduct of their classes it appears questionable that much thought is given to developing engineering judgment. Opinions are certainly varied on the manner and means for developing judgment, and perhaps it is only reasonable for it to be controversial. One point of view is expressed in the following paragraphs.

Among others, the subjects of engineering drawing, to which the following remarks are directed, provide a most excellent opportunity to introduce the inexperienced student to the habit of exercising judgment at a very early stage in his engineering education. Here it is that he can be shown and work with things of reality, things that have shapes, movements, characteristics—likenesses of which he has been able to observe since his mind was capable of it. Here it is that he can see the interrelationship of parts, moving or fixed, and the extent to which each affects the other. And because of these he can be called upon to express his own ideas as to how a simple part should be made to satisfy a given set of conditions, or to make simple improvements, modifications, or corrections to an object or machine that has been described as having certain undesirable characteristics.

Of importance then in enabling the student to present his expressions in the degree to which he is capable at that time is the selection and description of problems that he is assigned to work, the kinds of directions issued for obtaining their solutions, and of great importance the information, either in graphic or written form, that will exact his consideration of those outside factors which have a definite effect in the final decision to be made. This is a point which should be strongly emphasized, and a full realization of its merits and importance should be imbued in the student's mind. The mere existence of the same set of principal facts in two different cases does not necessarily lead to the same conclusion—outside factors can materially influence the results.

A type of problem that seems particularly appropriate in developing this habit may be called the "mating-parts" problem, for want of a better term. In contrast to the single, unrelated object that seems so widely used in present courses, the student recognizes that two or more pieces must fit together; that dimensions and shapes must be in agreement; that clearance of some amount needs to be provided; that certain surfaces need to be machined, and so on. This type of problem is adaptable to a variety of presentations. Some dimensions for the part to be drawn can be placed on the mating parts; all corners may be shown sharp requiring the student to decide which shall be filleted or rounded. The graphic data should be supplemented with word description giving dimensions not found on the graphic; giving modifications or corrections that need to be effected; giving instructions as to the operation of the parts; giving redundant data necessitating the student's selection of that which is relevant.

If the student is informed that engineering problems originate in much this same fashion, that he will have to separate the relevant from the irrelevant and to assimilate all known facts and influences, the problem becomes real and is removed from the very undesirable copy-type-problem category. Hence, his interest should be stimulated, his thought provoked, and he should be more able to render supporting comparisons and discriminations of observations and facts.

J. Howard Porsch

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Faculty and College Administrators

Applicants this list	88
Previously elected	840
Total	928

Industrial Administrators

Applicants this list	30
Previously elected	92
Total	122

Total New Members this List	118
Total New Members this Year	1050

Subject Index, 1948–49

Author Index, 1948-49

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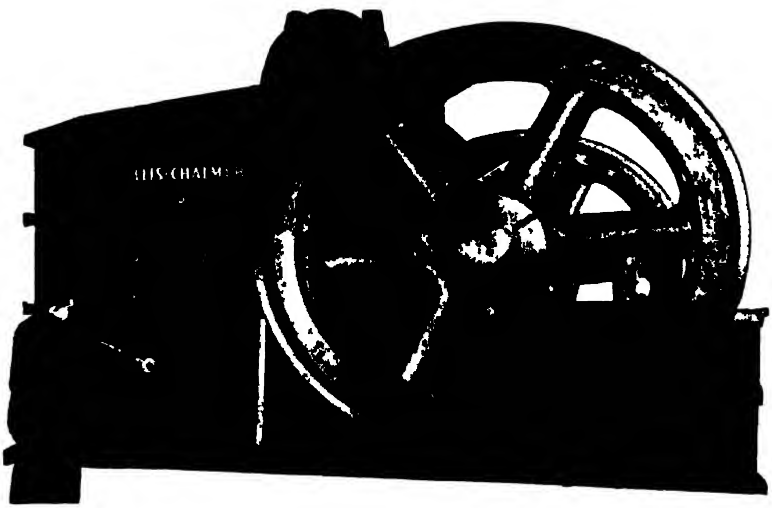

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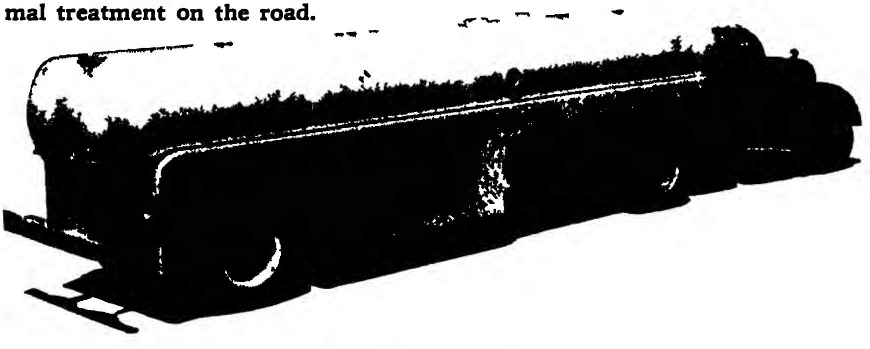

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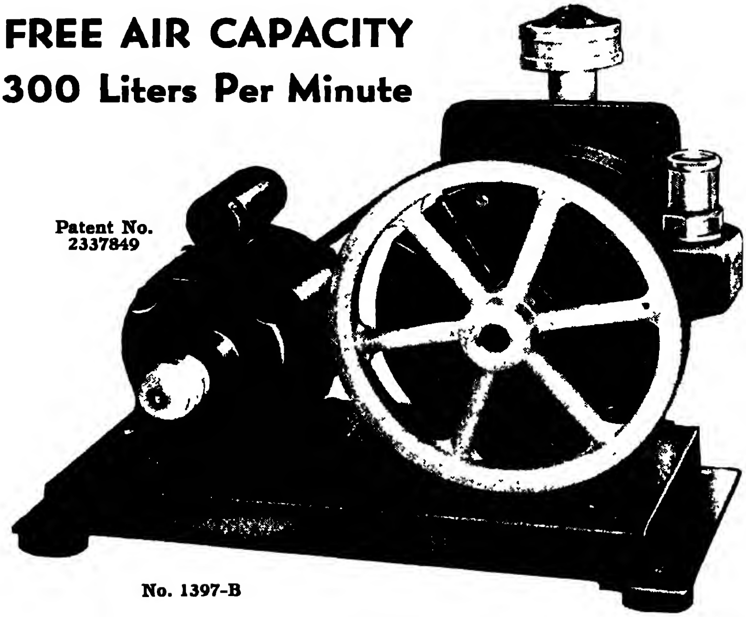

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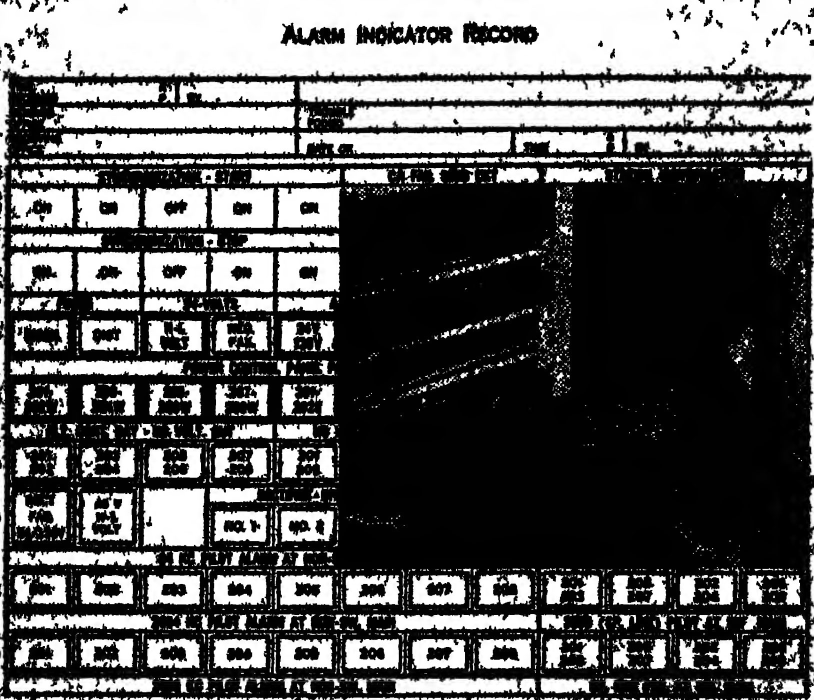

Carrying hundreds of telephone calls, coaxial cable runs through many lonely miles. Far from towns and people, [illegible] amplifying stations stand guard with a new [illegible] alarm system developed by Bell Telephone Laboratories.

[illegible] terminal, the man on duty [illegible] by laying a transparent [illegible] over a glass window [illegible] station hundreds of miles [illegible] the station gives an [illegible] flashing lamps [illegible] to report any abnormal [illegible] condition before it becomes [illegible]

But when something happens that threatens serious trouble, the apparatus acts at once—maybe by switching in a spare coaxial—and calls a distant test board by ringing a bell. Sometimes he can [illegible] by remote control; if not, he knows exactly how to [illegible] the [illegible]

With this new [illegible]

[illegible]

[illegible] TELEPHONE LABORATORIES

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ANNUAL MEETING—UNIVERSITY OF WASHINGTON,
Seattle, Wash.—June 19–23, 1950

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Other Wiley books on page 10

Thorndike Saville, President, A.S.E.E., 1949-50

The newly elected President of the Society, Thorndike Saville, has established an eminent reputation as educator, engineer and administrator. His academic accomplishments include undergraduate work in civil engineering beginning in 1910 at Harvard University and later at Dartmouth College, where he received the Bachelor of Science and Civil Engineering degrees. For two years he was a graduate student in hydraulic and sanitary engineering at M.I.T. and Harvard University, receiving the degree of M.S. from both universities. In 1944, he was awarded the honorary degree of Doctor of Engineering from Clarkson College.

During the first World War he was a 1st Lieutenant in the U. S. Army, where he was in charge of design and partial construction of the Big Bethel Water Supply and Filtration Plant for Langley Field and Fort Monroe. Upon termination of the War, Dean Saville was sent to England and France under a traveling fellowship from Harvard University to study river regulation and sewage treatment processes.

Dean Saville's academic career began in 1919 upon his appointment as Associate Professor and later Professor of Hydraulic and Sanitary Engineering at the University of North Carolina, where he remained until 1932. During this time he served as Chief Engineer of the North Carolina Geological Survey and its successor, the North Carolina Department of Conservation and Development, in charge of the water resources and engineering division.

In 1932 he accepted the post of Professor of Hydraulic and Sanitary Engineering at New York University and subsequently became Associate Dean and Dean of the College of Engineering at that University.

Dean Saville has inaugurated and carried out numerous research projects and has published over 40 articles in technical publications. Among the more important are: (1) "Nature of Color in Water," published as the result of research at Harvard in 1916, which laid the scientific background for several control methods used in water purification processes; (2) "The Cause and Prevention of Red Water Troubles"; (3) "The Water Supply of Caracas, Venezuela," describing the writer's work as Consulting Engineer in that country in 1926; (4) "The Power Situation in the South," published by the American Academy of Political and Social Science in 1931 and describing the past growth and future possibilities of hydro-electric power developments in the southern states; (5) "The Administrative Control of Water Pollution," a detailed study of the problem of investigation of stream pollution by Governmental Agencies in the United States and abroad; (6) "Inventory of Water Resources of the United States," National Resources Board, 1935; (7) "A Study of Methods of Estimating Flood Flows."

His extensive consulting practice includes a Rockefeller Foundation investigation of the water supply for Caracas made for the government of Venezuela; consultant to the U. S. Army Engineer's Board on beach erosion and sand movement; consultant to the U. S. Geological Survey and Mississippi Valley Committee on the investigation of flood frequencies; Executive Engineer of the Water Resources Section of the National Resources Board, and a member of the Water Resources Committee of this Board; consultant to the War Department on the Army Specialized Training Program; a member of the Governor's Technical Advisory Committee of the New York Department of Commerce; member of the National Advisory Committee, Engineering Science and Management

THORNDIKE SAVILLE

War Training Program; advisor on the Public Works Committee of the Hoover Commission on the reorganization of the Federal Executive Departments; Engineer member of the New York State Public Health Council; and a member of the National Advisory Health Council, U. S. Public Health Service.

He has taken a prominent part in activities of the A.S.E.E. as well as other

engineering societies. He was a member of the Council of the American Society for Engineering Education from 1942–45 and was Vice-President in 1948–49. He has also served on the Executive Committee of the E.C.A.C., E.C.R.C., Manpower Committee and numerous other committees of the Society. He has been a director of the American Society of Civil Engineers and President of the Metropolitan Section of that Society. He is a member of the following organizations: American Water Works Association; New England Water Works Association; Boston Society of Civil Engineers; American Institute of Consulting Engineers; American Association for the Advancement of Science, Vice-President (section M) 1943–44; Federation of Sewage Works Associations; American Society of Planning Officials; American Public Health Association; Harvard Engineering Society, President 1947–48; Harvard Club of New York City; Engineers Club of New York, Member Board of Governors 1947–52; Phi Beta Kappa; Sigma Xi; Tau Beta Pi; and the Mayflower Descendants.

Fall Meetings of E.C.A.C., E.C.R.C. and the General Council

The regular Fall Meetings of the Administrative Council and the Research Council will be held in Room 600 of the Kansas City Municipal Auditorium on October 28, 1949. The Morning Session will start at 9:00 A.M. and the Afternoon Session at 2:00 P.M.

There will be a breakfast meeting of the Executive Committee of E.C.R.C. at the Hotel Muehlebach at 8:00 A.M. and an Executive Committee luncheon of E.C.A.C. at 12:30 P.M.

The General Council will have a dinner meeting at the Hotel Muehlebach at 6:00 P.M.

The program for the Engineering College Administrative Council follows:

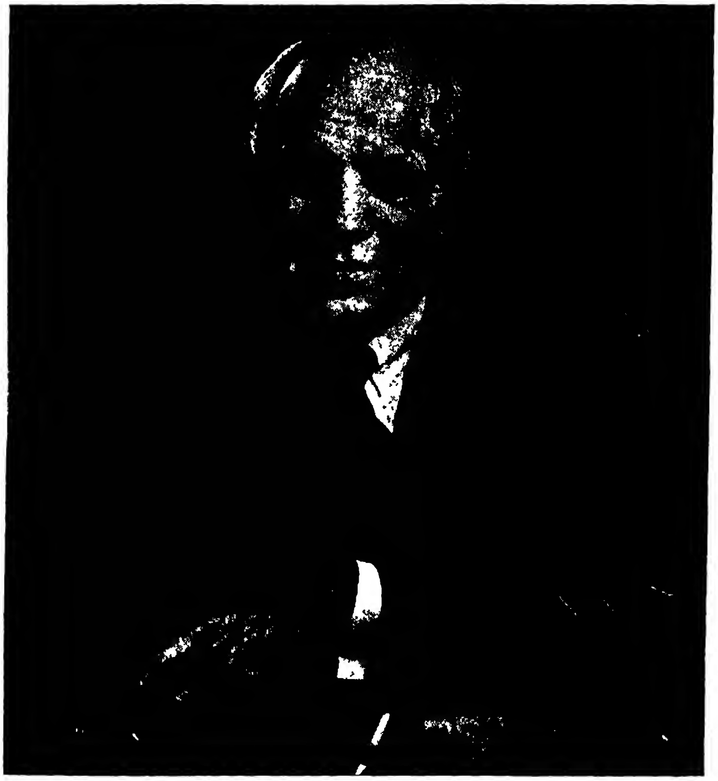
9:00 A.M. Room 600, Kansas City Municipal Auditorium.

1. "Impact of Atomic Problems on Engineering Education"—Dr. L. R. Hafstad, Director of Reactor Development, Atomic Energy Commission.
2. "Opportunities for Engineers in the Field of Nuclear Engineering"—Dr. L. B. Borst, Chairman, Reactor Science and Engineering Department, Brookhaven National Laboratory.
3. "Education for Nuclear Engineering"—Dr. K. H. Kingdon, Assistant Director of the Research Laboratory, in charge of Knolls Atomic Power Laboratory, General Electric Company.
4. "Chemical Engineering and Nuclear Energy Development"—Dr. Stephen Lawroski, Director of Chemical Engineering Division, Argonne Laboratory.
5. "The Environmental Engineering Aspects of Nuclear Activities"—A. E. Gorman, Sanitary Engineer, Atomic Energy Commission.

2:00 P.M. Room 600, Kansas City Municipal Auditorium.
Engineering College Research Council Program.

Room reservations can be made by writing directly to the Hotel Muehlebach and stating that reservation is being made for the American Society for Engineering Education Meeting.

Lamme Award—Karl Taylor Compton



KARL TAYLOR COMPTON

To Karl Taylor Compton for his achievements in scientific and engineering education as a teacher, research worker, administrator and author; for his broad understanding of the relation of education to production and of the engineering college to industry; for his leadership in evaluating staff, equipment and course content in accrediting engineering curricula; for his imaginative insight into the application of science and engineering to the defense of the Nation at war; for his wise counsel to the President of the United States and those in military leadership with him, we award this the twenty-second Lamme Medal.

KARL T. COMPTON was born in Wooster, Ohio, September 14, 1887; his father was a teacher and after graduation from Wooster College he became a teacher, which activity he has continued to this day. In the classroom, the office, the committee room, the commission, the Research Board and the Council of the President he has instructed those who would be taught. His first graduate de-

gree, Sc.M., was taken at Wooster College in 1909 and his Ph.D. was taken at Princeton in 1912. He has been awarded many honorary degrees from many colleges and universities: Doctor of Science, Doctor of Engineering, Doctor of Laws, Doctor of Applied Science, Doctor of Humane Letters. He began his career as an Instructor in Chemistry, College of Wooster in 1909. In 1913 he became Instructor in Physics, Reed College, and then went to Princeton University in 1915. He was Chairman of the Physics Department when he left Princeton to become President of the Massachusetts Institute of Technology in 1930. Dr. Compton was also summer lecturer at the Universities of Michigan, Cornell, Columbia, Chicago, and California. In 1934 he was Pilgrim Trust Lecturer, Royal Society of London.

For a number of years he was consulting physicist for the General Electric Company and for the U. S. Department of Agriculture.

Dr. Compton received the Rumford Medal from the American Academy of Arts and Sciences in 1931 and was awarded the Medal of Merit in 1946. In 1947 he received the Washington Award from the Western Society of Engineers and the Marcellus Hartley Public Welfare Medal of the National Academy of Sciences. He was made Honorary Commander of the Civil Division of the Most Excellent Order of the British Empire, and Commander of the Royal Norwegian Order of St. Olav in 1948.

Dr. Compton is the author of approximately 100 publications dealing with research in photoelectricity, ionization of gases, soft x-rays, spectroscopy in the extreme ultraviolet, fluorescence and dissociation of gases, electric arcs and other types of gas discharge, and other miscellaneous subjects in physics.

He is a member of the following fraternities: Phi Beta Kappa, Alpha Tau Omega, Tau Beta Pi, and Sigma Xi.

Dr. Compton is also a member of the Union and University Clubs of Boston, University Club of New York and Cosmos Club of Washington.

When the accrediting of engineering curricula was undertaken, Dr. Compton was chairman of ECPD's Committee on Engineering Schools. His excellent leadership guided the Committee through the early stages of the work and until the success of the program was assured.

He has been very active in the affairs of the American Society for Engineering Education. He served on the Council, 1933 1936, and from 1937 to 1946; he was Vice President, 1936–1937, and President, 1938–1939.

His work in the War effort was outstanding. His institution was a leader in research and he personally did his part in furthering the research and production of the Nation.

Dr. Compton was appointed by President Truman to succeed Dr. Vannevar Bush as Chairman of the National Military Establishment Research and Development Board, October 15, 1948, bringing to his new duties the benefits of a wide range of experience as scientist, administrator, and public servant.

In order to devote full time to the Research and Development Board, Dr. Compton resigned the presidency of the Massachusetts Institute of Technology, a position which he has held since 1930. He retains his association with the Institute, however, as Chairman of the Corporation.

Dr. Compton is actively interested in the strong impact upon society of technological progress and weapon innovations. In 1940 he was one of a small group of distinguished scientists which called upon the President of the United States and suggested to him the urgency of mobilizing American science to meet the impending threat of war. As a result of these recommendations, the President created by executive order the National Defense Research Committee, and Dr. Compton became one of its original mem-

bers in charge of the division responsible for detection, controls, and instruments. When the Office of Scientific Research and Development was created, the National Defense Research Committee became one of its principal operating arms. Dr. Compton retained his membership on the NDRC throughout the war, and, in addition, became Chief of the Office of Field Service, OSRD, where he directed the program of sending scientific experts into the war theaters to assist in the fullest exploitation of the new weapons which were being issued. His other wartime activities included the following posts: member of the Scientific Intelligence Mission to Japan; member of Secretary of War Special Advisory Committee on the Atomic Bomb; chairman of the United Radar Mission to the United Kingdom; member of the Baruch Rubber Survey Committee; member of the War Resources Board. He was also a member of a Special Committee on Postwar Research appointed by the Secretaries of War and Navy to make recommendations as to the best way of organizing military research in the postwar period.

In 1946, Dr. Compton became a member of the War Department Research Advisory Panel, Chairman of Joint Chiefs of Staff Evaluation Board on Atomic Bomb Tests, and a member of the Naval Research Advisory Committee.

Dr. Compton was appointed Chairman of the President's Advisory Commission on Universal Training which drew up a report on "A Program for National Security" and transmitted it to President Truman on May 29, 1947. In this report international, economic, educational, medical, and religious implications of universal military training were considered. The Commission also studied future kinds of wars and their risks. President Truman, in commending Dr. Compton on his work with the Commission, made the following statement: "The report of the Commission, happily unanimous, will I believe stand for decades to come as a definitive statement of the military policy of the United States."

In the News

In response to the request of those who attended the five Regional Conferences on University Research and Patent Problems in Atlanta, Berkeley, Chicago, Denver and New York, as well as others unable to do so, a summary report on all five conferences is being prepared.

There are approximately 70–75 pages to this report and it is available at $1.00 per copy, which is the cost of printing only. Orders should be sent to Patent Survey, National Research Council, 2101 Constitution Ave., Washington 25, D. C. Checks should be made payable to the National Academy of Sciences.

Dean S. S. Steinberg of the **University of Maryland** College of Engineering attended the First Pan-American Congress held in Rio de Janeiro, Brazil, July 15 to 24, as a guest of honor of the Congress. Dean Steinberg was Chairman of the United States Engineering Delegation of 40 engineers who attended the meeting.

Preceding the Rio Congress, there was held at Sao Paulo, June 9 to 13, a meeting of engineers representing all the countries of the western hemisphere to organize a Pan-American Union of Engineering Societies. In 1945 and in 1948, under the auspices of the Department of State, Dean Steinberg visited all 20 Latin-American republics on a survey of engineering and engineering education.

George Westinghouse Award—Joseph Marin

JOSEPH MARIN

To Joseph Marin for his effective contributions to the training of graduate and undergraduate students in the field of applied mechanics; for his important contributions, through research, to knowledge of the applications of principles of mechanics to the uses of engineering materials; for his many scientific and technical articles which have brought the results of experimental researches into reach of practicing engineers; and for his painstaking efforts to develop better teaching materials in the form of textbooks, class notes, problems, and laboratory equipment.

The engineering profession is proud to acknowledge its debt to Joseph Marin.

As an indefatigable research worker, as an enthusiastic and inspiring teacher, as a practicing engineer and consultant, and as an active member of professional societies, his services to the field of theoretical and applied mechanics have been manifold. Through his scientific papers he has made many important contributions to the knowledge of mechanical properties of materials and to the principles of stress analysis. He has assisted materially in bringing to the practicing engineer and designer some of the latest theoretical and experimental developments in engineering mechanics.

Although born in New York City on June 7, 1905, Dr. Marin spent most of his early years in Canada and received his Bachelor of Science degree in Civil Engineering from the University of British Columbia. His subsequent graduate work was carried on at the University of Illinois and as a pupil of Professor Stephen Timoshenko at the University of Michigan, where he was awarded the degree of Doctor of Philosophy in 1936. Dr. Marin served as Instructor in Civil Engineering at Rutgers University from 1930 to 1934 and at the same institution as Assistant Professor of Engineering Materials from 1934 to 1939. In 1939 he became Associate Professor of Civil Engineering at Illinois Institute of Technology. In 1942 he was appointed to his present Professorship of Engineering Mechanics at Pennsylvania State College.

Throughout his teaching career, Dr. Marin has contributed to the improvement of instruction of both undergraduate and graduate students. He is the author of several textbooks; he has prepared class notes for many graduate courses; and he has shown ingenuity in devising specialized laboratory equipment for instructional and research purposes. He has also continued to serve as an inspiring teacher to many engineers in the non-academic world by contributing clear and concise presentations of design solutions to various scientific and technical journals.

Doctor Marin was engaged in research and developmental work in the Turbine Division of the Westinghouse Electric and Manufacturing Company during 1937, and has been employed as consultant on stress analysis problems by the Curtiss-Wright Corporation and other companies since the beginning of the War.

He has directed numerous important research investigations in the mechanical properties of materials. Among the organizations for which he has carried on research projects are National Advisory Committee for Aeronautics, Welding Research Council, Wright Field, and Office of Naval Research. He is a member of the Executive Committee of the Society for Experimental Stress Analysis, an active member of many professional society committees, and maintains membership in American Society for Engineering Education, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, Society for Experimental Stress Analysis, Institute of Aeronautical Sciences, Sigma Xi, Phi Kappa Phi, Tau Beta Pi, and Chi Epsilon.

Professor and Mrs. Marin, the former Jean Brunton, whom he married in 1939, reside at Boalsburg, Pennsylvania.

Sections and Branches

The **Illinois-Indiana Section** members of the American Society for Engineering Education held their annual meeting on the campus of the University of Notre Dame on Saturday, May 14, 1949. The meeting was called to order at 10:00 A.M. and the group was addressed by the Reverend John J. Cavanaugh, C.S.C., President of the University of Notre Dame, by Dean Karl E. Schoenherr of Notre Dame, and by Harold S. Vance, President and Chairman of the Board, The Studebaker Corporation. Many of those attending the meeting took advantage of the conducted campus tour just before luncheon which was served at 12:45. The afternoon program consisted of seven technical sessions.

Program for the Year

By THORNDIKE SAVILLE

President of the ASEE and
Dean of Engineering, New York University

During the war years engineering colleges were confronted with numerous special training programs, a severe drop in normal student enrollment, and the departure of many faculty members for military and other national service. Quite naturally Society activities were markedly reduced, and those in effect were strongly colored by considerations of the national emergency. Recovery from the war posed still other new problems, and it has been only during the past year that some semblance of normality has returned. During that year the Society has been reinvigorated under the vigorous leadership of my predecessor Dean C. J. Freund. The officers have been stimulated to action in the realm of Society affairs for which they are respectively responsible, old committees have been reactivated and important new committees established, and the membership at large have evidenced a determination to make the Society function effectively in all of the areas contemplated by the Constitution. Indeed the Constitution itself has been revised.

All of this is most promising for the future. The Society is definitely not static. Many new members have been added to our rolls, and look to the Society for guidance, information, and as a medium for the exchange of new ideas relating to the many phases of engineering education. It is my purpose to help consolidate the progress which we have made, to try to keep our new activities and experiments within the limits of effective action, and to endeavor to make the influence of a Society of some 6500 professional engineering educators not only a constructive force in higher education, but an influence which should be brought to bear more effectively on national affairs.

The engineer presently occupies a higher place in public esteem than ever before. One may well argue that this is due in no small measure to the improvement in the character and scope of his professional education over the past twenty-five years. I believe this is an achievement of our Society membership, acting individually and collectively. But, preoccupied with our primary obligations to recruit new and competent faculties, to revise curricula, to meet new advances in science and technology, to improve the methods and aims of instruction, and to analyze the trends of employment and salaries as affecting our occupation, we have perhaps neglected to exert adequately our influence and prestige in social and economic matters affecting both the profession and the national welfare.

During the past year major efforts were made to improve relations with industry. An effective committee made dramatic strides in this direction, as evidenced by the program at our last convention. These gains should be consolidated and pursued further. On the other hand, we must not neglect that other area of engineering employment—the government services on all levels—federal, state, and local, long the chief outlet for civil engineers. The trends of the times clearly indicate a great increase in employment of all types of engineers in government activities. I hope during the

ensuing year that we may begin to formalize our relations in this field.

Perhaps never before in the history of the Society have we so many new and relatively inexperienced teachers on our faculties. We must bring to them, and to our older members too, some guidance as to effective teaching. The straight mechanics of good teaching have been neglected, and I look to the new committee suggested by Dean Hammond, and of which our Westinghouse Award winner, Dr. Teare, is Chairman, to begin an attack on all of the facets of this vitally important subject.

Wholly justified complaints have come in increasing volume the past two years from both our younger members and from certain of our ablest teachers, to the effect that our Divisions, Committees, and Councils are on the one hand concerned too greatly with topics of administration or research, and on the other hand that conferences at our annual convention tend to be monopolized by the views and papers of the older and more distinguished members. The younger and quieter men find little opportunity to be heard, and the papers too frequently represent individual views rather than fully considered group opinion.

President Freund and I collaborated last year in establishing a "young man's committee" to be restricted to those of instructor or assistant professor grade and under 30 years of age. Professor Frank L. Schwartz of the University of Michigan is Chairman of this committee. Its usefulness to younger members will depend solely upon the ideas they convey and the extent to which they participate in its activities. The formulation of problems for group study and report by the several Divisions and Committees was urged by me a year ago. Such projects when presented to the conferences will provide opportunity for constructive discussion, and will correlate importantly with the program of Dr. Teare's new committee.

The relation of junior and community colleges, and of technical institutes to the general problem of engineering education is increasingly important. The programs of our strong committees on these subjects merit the active participation of more of our members.

A scrutiny of our many Divisions and Committees in the Year Book, which I urge upon every member, shows ample opportunity for each member to participate actively and constructively in one or more of the intriguing aspects of engineering education. Only by such participation by a majority of our members can the Society remain alert, progressive, and useful. I regard my primary obligation to be concerned with the Society *as a whole,* and to that end I seek not only suggestions from officers and from Divisions and Committees, but from the membership at large. Will you not express to me or to other officers your thoughts as to what we should do and how we should do it, however radical or visionary they may appear? Only by ideas properly implemented may the Society effectively achieve its goals.

Coming in the October Journal . . .

A new feature, "Letters to the Editor." Letters, not exceeding 250 words, should be sent to the Office of the Secretary.

Engineering Education and Freedom from Fear*

By C. J. FREUND

Retiring President of ASEE and Dean of Engineering, University of Detroit

To be afraid of the atomic bomb is possibly the most common experience of people who live in civilized countries, except for concern to procure food, clothing and shelter. And when they can get the atomic bomb out of their minds, the people are tormented by reports of supersonic planes, guided missiles and biological inventions for the destruction of all animal and vegetable life over miles of countryside.

We are used to thinking about technological weapons only as they are utilized in warfare. But burglars, murderers and other criminals may likewise take advantage of the new technologies. Indeed, criminals have long used firearms, explosives, gas cutters and automobiles. People are not afraid of engineers, thank goodness, but they are excessively afraid of much that engineers contrive.

The engineer has mastery over the life and death of his fellow men. Hence it is of tremendous consequence that he shall have a keen sense of the difference between right and wrong. Engineers in Nazi Germany discarded their moral codes, or never had any, and we know what horrors resulted. A writer in the *New York Times* for February 28 of last year stated that "if Hitler, Goering, Bormann and the rest were the greatest criminals of the modern world, it is not because they were themselves supermen. . . . It is because they were obeyed by thousands of first class administrators and technicians who were politically neutral." Surely there is no greater menace in the world than a superbly competent engineer who is equally content to engage himself to a benefactor of the human race, or to some monster of cruelty and vice.

Responsibility for Moral Training

American engineers have generally been moral. But have we any right to assume that they always will be moral? Eminent thinkers have some misgivings in the matter. The impressive deliberations at the Massachusetts Institute of Technology three months ago, again and again shifted to the question of the moral responsibility of engineers and scientists.

Whose responsibility is it to make sure that engineers shall continue to be moral? It is difficult to impart to our students a sense of right and wrong, and we engineering educators might be tempted to consign the task to parents, pastors and school-teachers. However, we have already accepted a share of the responsibility. The Committee on Aims and Scope of Engineering Curricula of our Society reported that a major objective of engineering education shall be to develop "moral, ethical and social concepts essential to a satisfying personal philosophy, to a career consistent with the public welfare, and to a sound professional attitude."[1] We adopted that report in our annual meeting at the University of California in 1940. We must either repudiate that portion of the committee's report or make it our business to graduate moral engineers.

We must confess, I am afraid, that our actual accomplishments in the moral training of our students have been pretty meager. Except for an occasional endorsement of the Golden Rule we have little to show. If our engineers have been moral, it has not been particularly

* Presidential address presented at the Annual Meeting of the ASEE, June 21, 1949.

[1] JOURNAL OF ENGINEERING EDUCATION, Vol. 30, March, 1940, p. 564.

because we made them so. To quote Mr. C. E. Wilson in his February address before the American Institute of Electrical Engineers, "It is one of those strange quirks of human nature that most men are not at all embarassed or reluctant to discuss with their fellows the day-to-day technical and professional problems on which they are engaged; but the more their minds run to shop talk on any plane, the more tongue-tied and thought-tied they become when a general question of morals or human behavior is posed."[2] We understand the principles of science and of engineering, and we teach these principles to our students. But we do not teach moral principles, and I have a guilty feeling that we don't even know just what those moral principles are.

We all agree that we must impart moral insight to our students. But how shall we go about it?

Religion

It is my personal and deep conviction that we can finally and completely solve the problem of moral training only by religion. Apparently, I am by no means alone in this conviction. 95 per cent of the American people believe in God, according to a survey completed late last year.[3] As I get to know more of them, and to know them better, I find that many of our Society members are also church members. In the war years, when the annual meetings of our Society were held over week ends, the programs often featured religious services on Sunday morning. Engineering students at Princeton are registered for elective courses in religion. The University of Michigan has been planning for some years to institute a school of religion. Yale University has restored religion to an important position in the fabric of departments and courses. A year ago, in his address on the occasion of the inauguration of the president of the Case Institute of Technology, James Mooney asserted that "the engineer must recognize moral and spiritual values in life in order to have a sympathetic understanding of his fellow men. It is here that religion can do its part in making the engineer a full man."[4] And in "Human Destiny," Lecomte du Noüy declares that "if we have read the signs of the times correctly, or even if we have exaggerated some of the symptoms, the only salvation for mankind will be found in religion."[5]

Possibly I should explain that when I propose religion as the ultimate and complete solution of our problem, I do not mean the teaching of religion as an interesting field of knowledge by teachers who may themselves be altogether irreligious persons; I do mean the teaching of that very kind of dogmatic religion which so many intellectuals despise.

Of course, it is not feasible to teach religion in most of our colleges and schools of engineering, for good and sufficient reasons which we need not go into this morning. The great majority of us must get our students to know right from wrong by some expedient other than religion. What other expedients are there?

Ethics

Can we not teach ethics, the branch of philosophy—not of religion—which has to do with moral principles and moral deportment? Or rather, can we not plan to teach ethics? We cannot teach ethics immediately in all our schools because, for one thing, there are not enough qualified teachers.

Engineering educators are practical men; many of them will shrink from so abstract and intangible a subject as phi-

[2] "The Professional Estate," by C. E. Wilson, presented at a meeting of the American Institute of Electrical Engineers, Hotel Statler, New York City, February 2, 1949.

[3] "God and the American People," *Ladies' Home Journal*, Vol. 65, November, 1948, p. 37, *passim.*

[4] "Industry Considers the Scientist and Engineer in Public Affairs," *Society's Challenge to Technical Education*, Case Institute of Technology, Cleveland, Ohio, p. 14.

[5] P. 264.

losophy. They will ask, "What do you mean by ethics; what, precisely, shall we teach?" Resources of ethical subject matter are available to us. Great thinkers and teachers in all ages have announced principles and have evolved codes of ethics, and the civilized nations have accepted these principles and codes; or at least those nations which C. E. Wilson calls the God-fearing nations as contrasted with the God-hating nations.

Winston Churchill was talking about the principles and codes of ethics at the Massachusetts Institute of Technology when he spoke of "our inheritance of well-founded, slowly conceived codes of honor, morals and manners, the passionate convictions which so many hundreds of millions share together of the principles of freedom and justice. . . ." From the codes of ethics evolved over the ages, can we not extract condensed and simplified systems, and teach these systems in the schools of engineering? Can we not construct our subject matter upon the natural law, and upon the essential nature of man, his rights and obligations, and the rights and obligations of the family, the community and the state?

And in the business of putting together subject matter, can we not be guided by conscience, the instinctive faculty whereby we judge between right and wrong, even when we fail to act according to our judgment? Every day, every hour of our lives, we praise or blame some person or some influence, or we approve or disapprove some action. Conscience is almost always the basis of these spontaneous determinations?

Now, where shall we look for statements of ethical principles and codes? We may doubtless find most of what we need in the works of philosophers and moralists of the civilized nations: Aristotle, the Stoics, Cicero, Augustine, Thomas Aquinas and many others who have proclaimed the natural law. Moreover, may we not obtain valuable data from the writings of Jefferson, Franklin and other intellectuals and political economists of early America? These thinkers and authors recorded the sturdy moral code of their time. This code is possibly our finest distinctively American heritage, and may be responsible to a large degree for American prosperity and well-being.

You may ask, "Why explore in former ages? This is a new and a thrilling era; why not strike out for ourselves?" It is seldom prudent to discard experience. Why should we begin all over again? We don't in science and in engineering. Why should we rack our brains over problems which others have already solved? Why should we become entangled in perplexities which our predecessors have already unravelled? To quote again from James Mooney's Case Institute address, "Probably the gravest obstacle at present is a form of mental disease which seems to have spread throughout our country: some outgrowth of our trying to be too smart, a flaunting of all previous experience, a presumption that the experiences of the generations before us with similar problems are worth nothing. . . ."[6] Mr. Mooney's protest is especially appropriate because morality pertains to human nature, and human nature has not changed throughout the centuries.

It is reassuring, and to be expected, that the great philosophers of the civilized nations are agreed with respect to morality; or at least they agree in matters of everyday life: that men should tell the truth, respect the persons and property of others, obey the laws of the land. We have always accepted uniform and consistent opinion and experience as reliable standards and guides. Principles and codes of ethics have resulted from twenty-five hundred or more years of close observation of human deportment, and of concentrated thinking about such deportment, and the nature of man, by the keenest and the noblest minds.

Teaching Methods

So much for the subject matter of ethics. How to teach ethics may be

[6] *Op. cit.*, p. 11.

nearly as important as the subject matter. Presumably, we seek to acomplish two main objectives: (a) that our students shall master ethical principles and codes; (b) that they shall live and act according to these principles and codes.

If the student is to master principles and codes, the instructor must not only recite them, he must clarify them by abundant and graphic illustrations. It may be difficult to work up case material, but it can be done. The classes may study questions of professional ethics which have been argued before and recorded by the state boards for engineering registration. Some years ago, the editors of *Civil Engineering* submitted a problem in professional ethics in each of successive issues over many months; and in each succeeding issue, Professor Daniel Mead proposed a solution of the preceding month's problem. The purpose of the series was to clarify the relations of engineers with clients and employers, and with one another. Should not the instructor be able to prepare similar cases to illustrate those broader questions of general ethics which have to do with the relations of the engineer, as citizen, to the whole community?

And then there is the business of motivation. Unfortunately, you cannot make people behave by educating them. It has often been asserted, but none of us has ever seen it proved, that vice goes hand in hand with ignorance and virtue with enlightenment. Nothing will be gained if the engineering student discourses brilliantly on ethical principles and codes, and violates all of them after he graduates.

The instructor will certainly have to appeal to the known ideals and attitudes of young men. Students are hero worshippers; they look up to those who are strong and virile, and they are inspired by loyalty and integrity, and a willingness—even eagerness—to fight for what is right. The instructor will need so to represent ethical principles and codes as to make them appeal to the students. Besides, he will have to be the type whom students respect and admire. And he will obviously have to be moral and ethical himself, although he will need to be adroit about it, because it is socially quite impossible for anyone formally to set himself up as a model of good behavior.

Auxiliary Devices

The engineering faculty can be of great help to the teacher of ethics by promoting and encouraging student government associations, honor systems, religious foundations and other character building extra-curricular student activities. And they can vigorously support and defend the teacher of ethics, his teaching and his project, whenever and if ever they are challenged.

And when a school or college has adopted principles and codes of ethics for instruction, why should not each student be required to sign an endorsement of the principles and codes as a requirement for the degree; or still better, for promotion to junior standing? This would not be an airtight precaution, of course, because a few dishonest students would doubtless not hesitate to falsify the endorsement. However, many undesirable students would never even apply for admission to an institution in which such a "preposterous" requirement were imposed, and both students and the public would clearly see that the school means business.

None of us would hesitate to expel a student for thievery, conviction of felony or for any serious violation of good deportment. Why, then, should we train an immoral person in the potentially dangerous skills of applied science? Who of us wants to be responsible for turning out into the world a vicious or immoral man whom we have made proficient in the arts and sciences of engineering?

Conflict of Viewpoint

I realize, of course, that I may be out of line with certain prevailing viewpoints. It is the fashion of the moment to contend that knowledge can result only from the inductive method, from quantitative

research. The typical modern intellectual contemptuously rejects everything which cannot be proved in the laboratory or by laboratory methods. From this he concludes either one or the other of the following propositions:

(a) That even moral standards can be developed only in the laboratory, or by laboratory methods;
(b) That morality does not exist; that there is no such thing as right or wrong.

Sometimes I wonder about some of these modern intellectuals. I am thinking about a distinguished professor of sociology in one of our great universities. On a Friday morning he told his lecture class that morality is a fiction, a medieval superstition. On that Saturday afternoon he cultivated his garden and got into a quarrel with his neighbor on the other side of the fence. As the quarrel accelerated, the neighbor called the professor immoral. That made the professor very angry. He vaulted over the fence and soundly thrashed his neighbor.

The modern intellectual vigorously condemns the teaching of right and wrong because morality has not been established by experimental research, and hence, must be arbitrary and dogmatic.

But the modern intellectual subscribes to the doctrines of the Declaration of Independence and of the Preamble to the Constitution of the United States, which doctrines have not been proved by experimental research.

The modern intellectual talks enthusiastically about democratic institutions; and sometimes about free enterprise and private property; and he can't prove any of them by experimental research.

The modern intellectual is horrified by concentration camps; but he can't prove by experimental research that they are not altogether proper.

"Unless it comes out of the laboratory or is based on experiment, it is unproved dogma," proclaims the modern intellectual. But he can never prove this proclamation in the laboratory; hence his very proclamation is unproved dogma, according to his own definition. At one and the same time the modern intellectual renounces dogma and promulgates a notorious dogma. What a masterpiece of contradiction!

Methods of Experimental Science Not Appropriate in Moral Questions

On the other hand, if the modern intellectual asserts that moral standards can be developed by experimental research, he clashes with well known authorities whom we engineering educators regard very highly. For instance:

S.P.E.E. Committee on Engineering Education After the War:

> "The natural detachment so desirable in science will not suffice . . . where concepts of value and motivation of social conduct are involved."[7]

A.S.E.E. Committee on Academic Tenure, Professional Service and Responsibility:

> "The physical sciences have been exceedingly fruitful in engineering technology; so far they have been equally sterile in the technology of human conduct."[8]

Edmund W. Sinnott:

> "To many it (application of science) seems the only road which it is safe to follow. But there is a wide terrain into which this newest highway of the mind can never penetrate, a country where are found the rich facts of experience—subjective, primary, immediate; our emotions, desires, purposes, values, feelings of beauty and ugliness, of right and wrong, of love and hate."[9]

Arthur Compton:

> "Yet it is a narrow view to say that we should live only by that which can be subjected to scientific tests."[10]

[7] JOURNAL OF ENGINEERING EDUCATION, Vol. 34, May, 1944, p. 595.

[8] JOURNAL OF ENGINEERING EDUCATION, Vol. 36, June, 1946, p. 610.

[9] *Mechanical Engineering*, Vol. 70, February, 1948, p. 115.

[10] "Why I Believe in Immortality," *This Week*, April 12, 1936, p. 12.

Irving Langmuir:

". . . similar difficulties are found in all social problems, for their complexity is almost infinite compared to that of typical physical phenomena, and the ability to choose desirable experimental conditions and to repeat the experiment as often as desired is wholly absent." [11]

J. R. Oppenheimer:

"Science is novelty and change. . . . These qualities constitute a way of life which of course does not make wise men from foolish, or good men from wicked." [12]

Experimental research just won't work in moral investigations. A psychologist or a sociologist may observe the actions of a great many people in the most perfectly organized and the most carefully controlled experiments extending over a year or a decade. And when he has finished what does he have? He may have a conclusion indicating what people do or will do under a given set of conditions. But he can continue his experiments for countless years on end, and he will never discover what people *ought* to do; and what people ought to do is the object of morality.

Experimental research cannot be challenged in the physical sciences, and may be useful as an auxiliary device in the study of ethics. But if we are to create or to reinforce in our students a keen moral judgment, a rugged sense of right and wrong, shall we not have to indoctrinate them with principles which we have learned from philosophers and teachers who are the recognized guides of civilized peoples—and have been for twenty-five hundred years?

And if a change of policy could, in time, permit the teaching of revealed religion, so much the better.

Freedom from Fear

Engineering educators have accomplished difficult tasks in the past. Perhaps they can now undertake that hardest of all projects, the training of successive generations of highly moral engineers. If they succeed, the peoples of the world can be assured that the engineer will not prostitute his skills to the vicious designs of criminals or rascal dictators. And a reasonable hope for freedom from fear may be restored!

[11] "Science as a Guide in Life," *General Electric Review* (Reprint), Vol. 37, July, 1934, p. 6.

[12] Quotation in "The Scientists," *Fortune*, Vol. 38, October, 1948, p. 173.

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College Notes

The appointment of Charles N. Gaylord as chairman of the Department of Civil Engineering at the **University of Delaware** was announced today by Dean David L. Arm of the University's School of Engineering. Mr. Gaylord replaces J. W. Shields, who has resigned to become assistant general manager of the South Carolina Public Service Authority. With the rank of professor, Mr. Gaylord will assume his duties at Newark on Sept. 1. He has been professor of structural engineering, and assistant dean of the College of Engineering, at the University of Alabama.

Lee S. Whitson, chief industrial engineer at the Minnesota Mining and Manufacturing Company, St. Paul, was appointed professor of mechanical engineering at the **University of Minnesota.** Whitson will be in charge of the section of industrial engineering in the institute of technology.

J. Eldred Hedrick of New York City, senior technologist of the Shell Chemical Corporation, has been appointed a professor of chemical engineering at **Cornell University.** He will join the staff of Cornell's School of Chemical and Metallurgical Engineering this month.

Dr. Rolf Eliassen has been appointed professor of sanitary engineering in the department of civil engineering at the **Massachusetts Institute of Technology.** Dr. Eliassen, who assumed his duties at M.I.T. on July 1, will be in charge of the work in sanitary engineering at the Institute. This includes the graduate course in sanitary engineering as well as extensive undergraduate work in the field given within the civil engineering course. Dr. Eliassen will also supervise a research program in the analysis, purification, and disposal of industrial wastes, as well as studies in water supply contamination and purification.

Edward F. Degering, professor of chemistry and director of industrial research projects at Purdue University, has been named assistant chairman of chemistry and chemical engineering research at **Armour Research Foundation** of Illinois Institute of Technology.

Report of the Vice-President in Charge of General and Regional Activities

The activities of your Vice-President in charge of General and Regional Activities and his Committee on Sections and Branches may be divided into three general headings.

1. The general membership and its relation to Sections and Branches.
2. Section activities.
3. Branch activities.

General Membership

The map showing the geographical distribution of Sections and published in the JOURNAL for February, 1948 was developed to show the location of every faculty member or group of faculty members belonging to the A.S.E.E. In this way it was possible to determine the Branch or Section nearest to each of these members or groups.

This work was carried on in the belief that the strength of the Society lies in the interest of individual members and that the interest of the individual members is greatly affected by their activity in the Society. The member may be ever so philosophic in his attitude; he may retain a life-long membership because of the great service to engineering education rendered by the Society; but he will really be enthusiastic when he is able to take an active part in Society affairs. Then he begins to encourage his colleagues to join and become active and shortly the Society begins to feel the effect of increased interest and growth.

Wherever the map and our records indicated that there was a possibility that a member or group of members were not attending or were not associated with a Branch or Section of the Society, a letter was written to the individual or group asking whether they were attending the Branch or Section meetings nearest them geographically and calling attention to the calendar of Section meetings now being printed in each issue of the JOURNAL. Many replies were received, some of them apologizing for their lack of interest and promising to make an attempt to attend the Section meetings near them, while others indicated that their attention had never been called to the existence of a Section or Branch near them.

Section Activities

In our correspondence with the officers of Sections and Branches we encouraged the submission of suggestions for improvement in Society operation. A request was voiced from several sources that more attention be paid to the problems involved in teaching with less emphasis on problems of administration. This request applied to both Section meetings and the annual meeting of the Society. A letter requesting information was sent to the Sections inquiring about the type of program they were accustomed to prepare for Section meetings. Most Sections meet but once a year and an analysis made of programs from eleven Sections indicate that last year about thirty per cent of the time was spent discussing teaching techniques, and thirty per cent discussing curricula. Reports were obtained from only about two-thirds of the total Sections so the picture is not complete. There is, however, considerable variation in the programs of the various sections. Where the meetings included special groups of the various engineering divisions, such as civil engineering, draw-

ing, electrical engineering, etc., more time was spent on teaching techniques and round table discussions. It is suggested that some thought be given to this problem in case of future general programs for the national meetings.

Geographical extension of some sections has taken place to include schools that were formerly not affiliated with any Section. The North Midwest Section added the University of North Dakota, North Dakota State College, and South Dakota State College with the provision that these three schools are to act jointly in entertaining the North Midwest Section when it meets in their locality.

The Missouri Section has added the University of Arkansas, and the Rocky Mountain Section the University of Utah and Utah Agricultural College. There has been considerable discussion in the past few years on the formation of Sections of the Society in Canada. However, the schools are far apart and are often nearer a Section in the United States than to each other. The suggestion was made by the New England Section that Canadian schools in the Maritime Provinces be invited to join that Section. However, it appears at the present time, that the national conference of Canadian Universities has a Committee on Applied Science and Engineering Education. In order to avoid any misunderstanding, President Freund has written that committee and the matter will be discussed at their meeting in June of this year. The National Capital Section which became dormant because of other activities during the war has been reorganized through the efforts of Vice-President Steinberg and others. A new constitution and by-laws have been adopted and the name is changed to the National Capital Area Section.

There is still much to be done to make our Section organizations more effective. This is particularly true where the Section covers a large geographical area or where the terrain makes travel difficult. For example, the Pacific Northwest Section meets alternately on the East or on the West of the Cascade Mountains, and finds considerable difficulty in securing attendance when the meetings are held in a Montana school. Because their school problems are of similar nature the Montana schools prefer to belong to the Pacific Northwest Section.

Branch Activities

Correspondence with schools where there are organized branches of the A.S.E.E. indicates that they are extremely useful. Yet, there are only twenty-two such organizations in the United States. One Dean writes, "Having a branch means that your group is organized and whenever a concerted effort is needed the organization is in existence."

Meetings of the local branch are excellent mediums for discussions of teaching methods and techniques, relations between faculty and students, roads to success for young men entering the teaching profession, etc., etc. It is a good place to invite authorities on educational methods, our friends from the other colleges, practicing engineers, and employers to talk with us.

Where branches have been established, the local membership has increased, attendance at the section meetings has grown, and interest in the work of the National Organization and its objectives has been stimulated. After all, the A.S.E.E. is the only Society of national scope devoted exclusively to the profession of teaching engineering. As such, it is perhaps the most important agency through which engineering educators may express themselves. It is recognized by all state and national organizations and agencies.

Besides, the local branch is a good place to give rising young men a chance to develop leadership. Some of them should be elected to branch offices.

The Committee on Sections and Branches and the Executive Board believe that the activities of the present Branches exert an important influence on the development of engineering education and the future of the Society.

Letters received indicate that there are some extremely active Branch organizations. Very interesting and enthusiastic reports have been received from Michigan State College Branch, the Branch at the Michigan College of Mining and Technology, the Branch at North Carolina State College, the University of Washington Branch and others. As an example of the growth of membership, the University of Washington Branch started with thirteen members and now has fifty-three.

The Branch at the University of Alabama has organized a permanent committee on "Cooperation with Industry." They have been working with the Associated Industries of Alabama and members of this organization attended the A.S.E.E. Branch meetings. Later the Associated Industries entertained members of the University of Alabama Branch as guests at a panel discussion held in Birmingham.

The Minnesota Branch, in connection with the "Partnership with Industry" program of the National Society, conducted a three-day symposium on Industrial Engineering research, at the Center for Continuation Study. Nationally known speakers addressed the symposium which was attended by nearly 100 educators and representatives of industry. The program was planned by a joint committee of local industries and the A.S.E.E. and was financed by charging a registration fee of $8.00 for each person in attendance.

Because of enthusiastic reports from active Branches the Committee started a preliminary investigation to determine the attitude of schools toward Branch organizations. Schools with twenty-five or more members were contacted. From replies received, it appears that Branches could be organized in many schools to good advantage. This is particularly true where the geographical area of the nearest Section is large, and Section meetings are held only about once a year. Where the Section is small geographically and Section meetings can be held more frequently, Branch meetings seem to have little value. Although the replies were unanimous in agreeing that Branch activities were desirable from the standpoint of the local school and the Society itself, many schools reported that they were already over-organized and burdened with multiplicity of meetings of various kinds of engineering Societies and campus organizations. A successful Branch must have energetic backing and this cannot be expected where the faculty are already plagued by too many meetings. It is believed, however, that it would be very much worthwhile to encourage the establishment of Branches in localities where they can operate to advantage, and that much more can be done by organizing a limited number of Branches in suitable locations than by attempting a campaign of national scope for an increase in Branches of the Society.

Respectfully submitted,

B. J. Robertson, *Vice President in charge of General and Regional Activities and Professor of Mechanical Engineering, University of Minnesota*

June 10, 1949

Report of the Vice-President in Charge of Divisions and Committees for the Year 1948–49

Contact was continued during the year with all of the Divisions and Committees by means of two circular letters. The first pointed out the necessity for early programming of papers for the annual meeting, and the desirability of undertaking a certain number of long term projects by groups in the several Divisions and Committees which would result in group reports rather than in individual opinions. The second called attention to the desirability of increased collaboration with the Research Council in connection with research papers stimulated through the Divisions and Committees, and the possibility of certain joint sessions between Divisions and Committees and the Research Council.

A considerable amount of time was given to the stimulation of the Junior College Committee, together with its program and the initiation of a joint session with the Technical Institute Committee.

A policy with respect to summer schools was considered, and will be further amplified during the ensuing year. It is probable that a letter expressing the Society's general policy with respect to summer schools will be developed and sent to all Divisions and Committees, with a report to the next Vice-President in charge of this work.

A new committee was inaugurated under the chairmanship of Professor Schwartz to sponsor the interests of the younger men, membership in the committee to be restricted to those of assistant professor rank or less, and under 35 years old.

A letter was directed to the Divisions and Committees with respect to publishing resumés of their activities in the JOURNAL, to stimulate interest.

The Vice-President inaugurated the first general meeting of Division and Committee chairmen at a stated luncheon at the time of the annual meeting at Troy. This is believed to be a very necessary medium of general communication between the Vice-President in charge and the several Division and Committee chairmen. All of the chairman present expressed great interest in such meetings. Vice-President Robertson who will succeed me will undoubtedly implement many of the suggestions which were made.

The Vice-President in charge of Divisions and Committees attended all meetings of the Executive Board and Council during the year. He also participated as a member of the Society's Committees on Manpower, Salary, Constitution, and Military Affairs.

Respectfully submitted,

THORNDIKE SAVILLE, *Vice President in charge of Instructional Division Activities and Dean of Engineering, New York University*

July 2, 1949

Report of the Engineering College Administrative Council

The Engineering College Administrative Council of the American Society for Engineering Education has been most active and is making many contributions in the field of engineering administration. An excellent program was held in Washington, D. C., November 8, 1948. One of the highlights of the program was President Freund's address on the theme "Partnership with Industry." President Freund's paper, along with other papers presented at the meeting, has already been published in the JOURNAL.

The Executive Committee of the Engineering College Administrative Council held a meeting in Austin, Texas, June 17, 1948, and another meeting in Washington on November 8, 1948. At these Executive Committee meetings programs for the general meetings and conferences were organized and, in addition, committees were activated to carry out regular and special assignments for the year.

In addition to appointments of committees, new By-Laws were enacted under date of August 1, 1948, and approved by the Society effective July 1, 1949.

Special Report

Building Study Survey, Dean J. H. Lampe, University of North Carolina, Chairman.

At the November 8, 1948, meeting of the Executive Committee of the Engineering College Administrative Council, Dean Lampe submitted a report of the Building Study Survey. After discussion he was authorized to issue a final report restricting information to include only building facilities for instruction and research work in engineering completed or authorized since January 1, 1945. This final report was issued to the membership as of March 7, 1949. (A copy is attached as Appendix II.)

Committee Reports

Salary Study Committee, Dean W. C. White, Northeastern University, Chairman.

Real progress has been made by the Salary Study Committee in its work of comparing teaching salaries in engineering institutions with teaching salaries in other professional schools and with engineering salaries in industry.

The problem of comparing teaching salaries with engineering salaries received in industry is a very difficult one. However, at its meeting in Detroit on October 30, the Committee decided to use as an industrial salary basis the data contained in the report of the Engineers' Joint Council entitled "The Engineering Profession in Transition."

A full report was presented by Dean White, chairman, at the annual meeting on Thursday, June 23, 1949, at Troy, New York. Bound volumes of this report were distributed. A final report is to be made to the Carnegie Corporation in the near future, after which the Committee will have completed its work.

The membership of the Salary Study Committee is: Dean W. C. White, Northeastern University, *chairman;* Dean C. L. Eckel, University of California; President T. K. Glennan, Case Institute of Technology; Dean Thorndike Saville, New York University; Mr. Malcolm Kispert, Massachusetts Institute of Technology, secretary; Dean S. S. Steinberg, University of Maryland, member ex-officio.

Committee on Military Affairs, D. B. Prentice, Scientific Research Society of America, Chairman.

Dr. Prentice has given much personal thought and consideration to the current situation of Selective Service and R.O.T.C. problems as they relate to engineering colleges. Present plans call for selection of individuals by the local boards with full discretion rather than on the basis of directives from national headquarters. Any memoranda from General Hershey's office will be advisory, not mandatory.

While no specific changes in the administration of the R.O.T.C. have been ordered for the current academic year, plans are being considered, apparently, which would introduce many serious difficulties for the engineering colleges during the year 1949–50. It has been indicated that specialization of course material might be included in the freshman and sophomore years for R.O.T.C. students. A freshman engineering student might elect signal corps, engineer corps, artillery or any other branch offered and the hour plan would have to provide for this freedom of choice. Such a development would introduce serious scheduling difficulties and requires added time for the R.O.T.C. program.

On Wednesday, June 22, at 2:00 P.M., the Committee on Military Affairs held a meeting in the Troy Building, Dr. D. B. Prentice, chairman, presiding. The theme of this meeting was the consideration of Selective Service, R.O.T.C. and N.R.O.T.C. matters. The program was as follows:

1. Selective Service and the Engineering Colleges. Major General L. B. Hershey, Director of Selective Service.
2. Discussion opened by Dr. M. W. Trytten, National Research Council.
3. Plans of the Reserve Officers Training Corp. Brig. General W. Westover, R.O.T.C., Lt. Colonel G. M. Bacharach, R.O.T.C.
4. Discussion opened by T. Saville, Vice-president A.S.E.E., New York University.

The membership of the Committee on Military Affairs is: D. B. Prentice, *Chairman;* Dean N. S. Hibsham, Pratt Institute; Dean Thorndike Saville, New York University; Dr. M. H. Trytten, National Research Council; President M. D. Whitaker, Lehigh University.

Manpower Committee, Dean L. M. K. Boelter, University of California, Chairman.

Reports of the Manpower Committee show that the committee has had one meeting and very effective activities through correspondence and keeping abreast of the manpower problem.

Dean Boelter, chairman of the committee, started this year's activities through a joint understanding with Mr. M. M. Boring of the Engineering Joint Council's General Survey Committee. The Engineering Joint Council is accumulating information concerning starting rates currently offered engineering seniors and graduate students, and also information concerning the demand for engineering graduates this year as compared with last year.

The Manpower Committee plans to use the information obtained by the General Survey Committee of the Engineering Joint Council as basic data for the report. Further, the committee will work closely with the Bureau of Labor Statistics on the problems of manpower requirements for professional engineers. The committee is also conducting this study to determine the rate of utilization of United States engineering college graduates.

At the June meeting of A.S.E.E. the Manpower Committee had a most effective program. A sub-committee consisting of Messrs. Armsby, *Chairman,* F. M. Dawson, Thorndike Saville, and S. C. Hollister prepared a summarization report on the manpower situation. This report was presented at the general session of E.C.A.C. by H. H. Armsby.

The Manpower Committee held a special conference at 2:00 P.M. on Thursday, June 23, Dean Boelter, *Chairman*, presiding. The program was as follows:

1. 1949 Demand for Engineering Graduates.
   a. M. M. Boring, General Electric Company.
   b. D. S. Bridgman, American Tel. & Tel. Company.
2. Employment Outlook for Engineers, H. Goldstein, Bureau of Labor Statistics.
3. Report of Subcommittee, H. H. Armsby, *Chairman*, U. S. Office of Education.

The membership of the Manpower Committee is as follows: Dean L. M. K. Boelter, University of California, *Chairman;* H. H. Armsby, U. S. Office of Education; M. M. Boring, General Electric Company; M. T. Carpenter, Research Dept., Standard Oil Co.; F. M. Dawson, University of Iowa; O. W. Eshbach, Northwestern Technical Institute; E. P. Hamilton, John Wiley & Sons; E. V. Hollis, U. S. Office of Education; S. C. Hollister, Cornell University; R. M. Kimball, Massachusetts Institute of Technology; C. T. Reid, California Aero. Technical Institute; Thorndike Saville, New York University; W. W. Squier, Sun Electric Corporation; M. H. Trytten, National Research Council.

Committee on Secondary Schools, Dean Everett D. Howe of the University of California, Chairman.

Dean Everett D. Howe most graciously accepted the work of directing this committee late in November, 1948, to succeed Dean Boelter who was relieved of the chairmanship in order to direct the work of the Manpower Committee.

The Committee on Secondary Schools held a special conference at the Troy meeting at 2:00 P.M., Wednesday, June 22, Dean Everett D. Howe, *Chairman*, presiding. The meeting was a panel discussion based on brief preliminary talks by panel members on the following topics:

1. Secondary Schools No. 1—"Secondary School Curriculum Problems as Related to Preparation for the Study of Engineering," Mr. Hamilton Acheson, Cobleskill Central School, Cobleskill, N. Y.
2. Secondary Schools No. 2—"Aims and Objectives of High School Mathematics and Science Courses," Mr. James T. Hepinstall, Philip Schuyler High School, Albany, N. Y.
3. Secondary Schools No. 3—"The Guidance Program in the High School," Dr. Carleton A. Moose, New York State College for Teachers, Albany.
4. Technical Institutes—"Skills and Knowledge Prerequisite to Technical Institute Curricula," Mr. Walter L. Hughes, Franklin Technical Institute, Boston, Mass.
5. College No. 1—"Selection of Students for the Study of Engineering," Professor Harry W. Case, University of California, Los Angeles.
6. College No. 2—"Socio-humanistic Studies in College, as Related to High School Preparation," Professor Jesse E. Thornton, University of Michigan.

In addition to the panel discussion there was a report on the National Council of Teachers of Mathematics by Dr. H. H. Armsby.

The membership of the Committee on Secondary Schools is as follows: Dean Everett Howe, University of California, *Chairman;* H. H. Armsby, U. S. Office of Education; W. S. Evans, University of Maine; M. P. Gaffney, New Trier High School, Monetka, Illinois; Professor A. B. Garrett, Ohio State University; W. L. Hughes, Franklin Technical Institute; P. G. Johnson, U. S. Office of Education; F. H. Miller, Cooper Union; J. G. Potter, A. & M. College of Texas; J. E. Thornton, University of Michigan.

The Executive Committee of the Engineering College Administrative Council consisting of the former and new members held a luncheon meeting, Thursday, June 23, 1949, at 1:00 P.M., during the meeting at Troy, New York. General business of the Council was conducted and arrangements looking forward to our fall meeting at Kansas City on October 28, 1949, were expedited.

The new officers and Executive Committee members who were elected at the Troy meeting are as follows: Dean F. E. Terman, Stanford University, *Chairman;* Dean J. H. Lampe, N. C. State College, *Secretary;* President A. S. Adams, University of New Hampshire; Dean O. V. Adams, Texas Technological College; Dean Kenneth A. Condit, Princeton University; Dean R. E. Vivian, University of Southern California; President F. L. Wilkinson, Jr., Rose Polytechnic Institute.

Respectfully submitted,

S. S. STEINBERG, *Vice President of the Society and Dean of Engineering, University of Maryland*

J. H. LAMPE, *Secretary of the E.C.A.C. and Dean of Engineering, University of North Carolina*

June 29, 1949

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	Spring, 1950	D. M. Griffith, Bucknell University
Illinois-Indiana	Purdue University	May 13, 1950	D. S. Clark, Purdue University
Middle Atlantic	Columbia University	Dec. 3, 1949	R. T. Weil, Jr., Manhattan College
National Capital Area	Washington, D. C.	Oct. 4, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Nov. 3, 4, and 5, 1949	C. J. Posey, University of Iowa
Pacific Northwest	University of Idaho	1951	A. S. Janssen, University of Idaho
Pacific Southwest	Stanford University	Dec. 28 & 29, 1949	R. J. Smith, San Jose State College
	Virginia Polytechnic Institute	April 20, 21, & 22, 1950	H. G. Haynes, The Citadel
	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University
	University of Rochester	Oct. or Nov., 1949	H. W. Bibber, Union College

Report of the Engineering College Research Council 1948-49

As 1948–49 comes to a close, the Engineering College Research Council finds itself better than usually equipped to survey the area of its assignment.

Engineering research in all colleges and universities has grown at an exceedingly rapid rate in the years during and following World War II. This year the Research Council has a quantitative report on the size of this great collective enterprise.

Printing has just been completed on pre-publication copies of the 1949 *Review of Current Research and Directory of Member Institutions*. In this book is listed the title of each research project in engineering at each one of the Research Council's 81 member institutions. This 1949 edition is almost one-third again as large as its counterpart published in 1947. There are more than 4000 research project titles in it, representing over $35,000,000 in research expenditures.

The growth in engineering research activity is not confined to a few institutions or even to a section of the country. Fundamental research in engineering is underway in important proportions in every state of the Union. The Research Council's membership reflects this fact. To qualify for active membership in the Engineering College Research Council, a school must spend upwards of $10,000 over a three-year period on fundamental engineering research. In the past six months eight additional schools have met these qualifications and have become members of the Engineering College Research Council. They are:

University of Arkansas (College of Engineering)
Catholic University of America (School of Engineering and Architecture)
University of Denver (Industrial Research Institute)
Montana School of Mines (State Bureau of Mines and Geology)
Northeastern University (College of Engineering)
University of Notre Dame (College of Engineering)
Tufts College (School of Engineering)
Wayne University (Wayne Engineering Research Institute)

Earlier, in the fall of 1948, the University of California (Los Angeles) Department of Engineering was accepted for Active Membership.

The Administration of Research

As a great enterprise, engineering research in colleges and universities presents difficult and unconventional managerial problems. Last fall, because more information was needed about dealing with these unconventional problems, the Research Council sent a special questionnaire on sponsored research to all its members; more than 60 replied.

Nearly half of the 60 schools reported *no men* employed *full time* exclusively on sponsored research. Such research is being done by men who spend part of their time in the classroom, either teaching or studying, and part of their time in the laboratory. More than 800 engineering faculty members alone in these 60 institutions are engaged part-time in sponsored research activities, and their work represents about 8 per cent of the total faculty time. With very few exceptions, their participation does *not* re-

sult in any personal monetary gain. These facts would seem to indicate nearly perfect integration of research into educational activities.

Sponsored research in our engineering colleges is not a commercial money-making venture. It is a sound correlation of education and research serving industry as well as our educational programs, a vital part of our national life and welfare.

Because the problems of research administration are so complex and at the same time so important, the members of the Engineering College Research Council have been well represented at the Conferences on the Administration of Research at the Pennsylvania State College, beginning three years ago. At the invitation of the group, the Research Council is now preparing to assume a more active role in this activity, as one of several cooperating organizations.

Education in Research

The E.C.R.C.'s new *Review of Current Research,* which covers both sponsored and unsponsored activities, reports that 10,000 men and women are now taking active part in engineering research at educational institutions. Nearly half of these people are graduate students and more than another quarter are members of the teaching staffs. Of the 4000 research project titles reported, about one-quarter are sponsored by industries and industrial associations and one-quarter by military and civilian agencies of the government.

These figures all lead to one inevitable conclusion: the colleges and universities which are members of the Engineering College Research Council have, by a variety of administrative methods, achieved universally a remarkable coordination of effort between research and education. It is widely recognized that fundamental research is a necessary part of advanced education in engineering and a necessary background in schools where effective undergraduate instruction is to take place. Here is evidence that such basic research, some of it for outside sponsors whose interests are not fundamentally in education, can indeed become part and parcel of the educational process and a part of the very academic life at each institution involved. In the *Review of Current Research* there is the best possible evidence in support of the conviction that educational institutions can (and must) maintain their activities in fundamental research—integrated with education and free from those routine projects which commercial research organizations are formed to study.

Research Council Publications

This story of educational institutions' fundamental research is one worth telling, and it is to this purpose that the Research Council's publications activities are directed.

In order to help its members tell the story of their activities, the Research Council met in Washington, D. C., in November, 1948, to hear seven editors and writers describe how to help professional writers deal with engineering subjects. The seven speakers and their papers were:

Herbert B. Nichols, Science Editor of the *Christian Science Monitor:* "Applied Science in the Daily Press."

John M. McCullough, Editorial Staff of the *Philadelphia Inquirer:* "The 'Working Press.'"

Ron Ross, News Editor of *Science Service:* "Science Service."

Irving J. Gitlin, Science Director of the Columbia Broadcasting System: "Science on the Radio."

Edward D. Fales, Associate Editor of *Science Illustrated:* "Photographs and Diagrams: How the Magazines Can Help."

Paul Wooton, President of the National Conference of Business Paper Editors: "The Business Press."

Philip W. Swain, Editor of *Power:* "Research in the Engineering Press."

One permanent result of this meeting is a little booklet of Proceedings containing the seven papers, entitled "Telling the

Story of Engineering Research." It is full of wise words and good advice for all engineers (and scientists) who would like to help newspapermen and editors and writers describe what has been accomplished, what is underway, why, and how. This booklet has already achieved a warm reception in both engineering and journalism circles; its publication may eventually be a financially self-supporting project.

In addition to the *Review of Current Research* and the booklet on "Telling the Story of Engineering Research," the Research Council published the Proceedings of its 1948 Annual Meeting during the past few months. This volume contains those papers given at Austin, Texas, which were deemed of special interest to research directors and administrators. Like other publications of the Research Council, copies of the Proceedings are sold at approximately the cost of printing. But the cash sales of most publications are small and complimentary distribution is relatively large; thus the dues received from Active Members in the Research Council actually make much of the publications program possible. The publications represent the Research Council's major expenditure, both of time and of money.

Research is Necessary to Progress

The Engineering College Research Council program for the 1949 Annual Meeting, as for last year's, carries as a slogan the truism that "Research is necessary for progress in engineering." It is in recognition of this fact that the Research Council has become an integral part of the American Society for Engineering Education. It is charged with assisting in the development of research facilities in engineering colleges. It is the hope of the Executive Committee of the Research Council that what has been accomplished this year may have helped to fulfill that charge. The Committee pledges its continued efforts toward a wider and better understanding of the role of fundamental research in educational institutions and in American life.

Respectfully submitted,

F. M. DAWSON, *Vice President of the Society and Dean of Engineering, State University of Iowa,*

J. I. MATTILL, *Secretary, Engineering College Research Council, and Assistant Director of News Service, Massachusetts Institute of Technology*

June 10, 1949

Secretary's Report

The past year has witnessed a number of significant accomplishments contributing to the long-range objectives of the Society. The theme "Partnership with Industry," proposed by the President and endorsed by the Executive Board and the General Council, met with widespread approval among the Divisions and Sections of the Society, as evidenced by the many varied programs bearing upon this general theme. These meetings have served to establish a closer liaison between engineering colleges and industry, thereby providing a better understanding of the mutual problems and relationships of both.

Several new projects have been undertaken by Committees and Divisions of the Society, and considerable progress is being made on other studies now under way. When completed, these projects have promise of making significant contributions to the advancement of engineering education.

The Administrative Council and the Research Council have held highly successful meetings on subjects of widespread current interest. Separate reports on these activities are given by the Vice Presidents in charge of the Councils.

Ethics of Interviewing Procedures

During the past year, the Committee on Ethics of Interviewing Procedures completed its report "Recommended Procedures in Interviewing and Placement of College Seniors." The report was approved by the General Council of the Society in November, 1948, and was published in the March, 1949, issue of the JOURNAL. Approximately 1200 copies of the report were sent to presidents, deans, and personnel men in colleges, as well as to personnel men in industry. Numerous letters of commendation have been received, testifying both to the need for such a code and the excellence with which the Committee has discharged its responsibilities.

Visual Aids Projects

In order to facilitate the preparation of visual aids suitable for engineering instruction and to encourage their use, a Committee on Visual Aids has been formed under the Division of Educational Methods. This committee is formulating plans for industry-college cooperation in the construction of films, slides, working models, and other devices which would help to improve engineering instruction. As a means of providing a widespread exchange of ideas on visual aids, the Committee has arranged for a symposium on this subject at the annual meeting, as well as an exhibit of various audio-visual aids and models prepared by engineering faculty members.

Measurement and Guidance Project

A Measurement and Guidance Project has, for a number of years, been jointly sponsored by the A.S.E.E. and the Engineers' Council for Professional Development. The project, financed in part by the Carnegie Foundation, was responsible for constructing, administering and grading the Pre-engineering Inventory Tests and the Sophomore Achievement Tests. During the past year an organization known as the Educational Testing Service was founded for the purpose of consolidating the testing services in various educational fields, including the College Entrance Board Examination, the Graduate Record Examination and others. The new Educational Testing Service was financed by the Carnegie Foundation

which concurrently withdrew its support from the Measurement and Guidance Project as a separate testing project. In November, the General Council of the Society voted to approve a three-way agreement with the E.C.P.D. and the Educational Testing Service, whereby the Measurement and Guidance Project would be transferred to the Educational Testing Service. The agreement, which does not impose any financial obligation upon the Society, provides for an Advisory Council with representatives from the A.S.E.E. and E.C.P.D. to assist the Testing Service in the administration of the project.

Teaching Manual

A manual on effective teaching methods is being prepared by a committee of the Society. The Manual will be published by McGraw-Hill Book Company.

Enrollment Statistics

For a number of years the Society has collected and tabulated statistics on enrollment in engineering colleges. Various agencies of the U. S. Government have expressed considerable interest in these statistics and the U. S. Office of Education has offered to handle the work of tabulating the statistical data. An agreement has been prepared, whereby the U. S. Office of Education and the A.S.E.E. would cooperate in the preparation of the engineering enrollment statistics. This agreement was approved, with modifications, by the Executive Board and was approved by the General Council at its meeting on June 24, 1949.

Constitutional Amendments

The Committee on Constitution and By-Laws has prepared a number of constitutional amendments to correct certain provisions in the Constitution which have given operational difficulty. These amendments were approved by the three Councils of the Society at the Annual Meeting and will be submitted to the Society membership by letter ballot for ratification.

Participation in American Standards Association

The Society is taking an active part in the work of various standards committees of the American Standards Association. New representatives have recently been appointed to committees in the fields of civil engineering, physics and electrical engineering, and engineering drawing.

Summer School

A summer school, sponsored by the Mechanical Engineering Division was held at Rensselaer Polytechnic Institute following the Annual Meeting. The program included teaching methods, professional development of the instructor, subject material for general and specialized mechanical engineering courses, integration of the curriculum, professional development of the student, and preparation of the student for his first job.

Activities for Younger Members

A committee has been appointed to submit proposals for activities which would increase the participation of younger members in the affairs of the Society. It was the opinion of the Executive Board that the younger members, of instructor and assistant professor rank, should be given an opportunity to organize activities which would appeal particularly to their interests and make it possible for them to participate more actively to the affairs of the Society.

Journal of Engineering Education

The new cover design of the JOURNAL, with the rotating color sequence for consecutive months, has met with enthusiastic approval. The new type size and format effects an appreciable saving in printing costs, with very little impairment of readibility.

A complete listing of officers of the Society was included in the October issue and a page giving the dates of Section meetings was included in each issue. This practice will be continued in the future. It is planned to include a "Letters

to the Editor" page in future issues of the JOURNAL. A page will also be made available to Divisions and Committees of the Society in future issues of the JOURNAL.

Annual Meeting

The local committee at Rensselaer Polytechnic Institute is to be commended for the zeal and enthusiasm with which they handled the preparations for the Annual Meeting. Excellent cooperation has also been received from the Divisions and Committees in completing the program arrangements early in the year. A considerable amount of liaison work is necessary between the host institution and the Secretary's Office in assigning conference rooms, dining rooms, and in eliminating the many inevitable conflicts. It is therefore necessary to set an early deadline date for program information in order to assure mailing of the preliminary program before the first of May.

This year, an attempt has been made to get out advance publicity releases on the Annual Meeting. Summaries of talks were also mimeographed for distribution at each of the conferences.

Partnership with Industry

The Committee on Relations with Industry has taken an enviable lead in developing the theme for the year by arranging for an industry-college forum at the Annual Meeting on the subject "Development of the Young Engineer." Outstanding industrialists were invited to speak on: licensing of the engineer, the engineer and unionism, and professional development of the engineering graduate. Invitations to attend the meeting were sent to a select list of industrialists and college administrators throughout the country. The Committee on Relations with Industry also made arrangements for one of the general sessions on the subject "Industry-College Relations."

International Night

The Committee on International Relations extended invitations through the embassies in Washington to engineering educators throughout the world to attend the Annual Meeting of the Society and to participate in an International Night dinner and conference. This meeting was attended by approximately 45 engineering educators and administrators from foreign countries, in addition to officers and members of the Society. The international delegates spoke on the background and current problems associated with engineering education in their respective countries. Meetings of this character will inevitably extend the benefits of the Society activities into many lands. They will help to establish the bond of friendship among engineering educators throughout the world and impart a deeper understanding of each other's problems and goals. The Committee is to be highly commended for its pioneering work

Section Meetings

Interest in Section activities has shown a marked increase, as evidenced by the fact that attendance at most Section Meetings exceeded all previous records. The Sections and Divisions are to be commended for the high quality of programs at their various meetings. It is heartening to note that, in Section and Division meetings, increased emphasis is being placed upon methods of improving engineering instruction. For many years, the primary emphasis has been upon "what should be taught," whereas during the past year considerable emphasis has shifted to "how can it best be taught."

A number of deans of engineering colleges are encouraging their younger faculty members to attend the Section meetings, since these meetings make it possible for them to get the benefits of society participation at considerably less expense than attendance at an annual meeting of the Society.

Membership

The Membership Committee nas consisted of a chairman for each state and committee members from each engineer-

ing college within the state. The energetic work of this committee has resulted in the addition of 1050 new members during the year, representing an 18 per cent increase in membership. Approximately 4500 letters of "invitation-to-join" were sent to prospective members whose names were supplied by the membership committee. An effort was also made to increase the membership of the Society from among the ranks of industrial executives who have shown an interest in engineering education. Recommendations of prospective industrial members were solicited from deans of engineering colleges and members of the Committee on Relations with Industry, and letters of "invitation-to-join," signed by the President, were sent to each prospective member. This has resulted in 122 new industrial members.

During this year, there have been 162 resignations, 29 deaths, and 53 members dropped for non-payment of dues.

Finances

The inescapable inflation in prices has been felt just as acutely among engineering societies as it has in other walks of life. A little over a year ago the Society was informed of a 20 per cent increase in the cost of printing the JOURNAL and in January of this year an additional 22 per cent increase was announced. Other items of Society expense have suffered similar increases.

Despite rapidly rising costs, the Society has successfully maintained a balanced budget and the Treasurer's report shows a profit of $3741.02 in the year's operations. This can be attributed largely to the success of a vigorous membership campaign and the solicitation of increased advertising in the JOURNAL during the past two years. Together, these two items have increased the annual revenue of the Society by $11,500.

There are, however, certain conspicuous omens which cannot safely be ignored. If prices should continue to rise in the future as they have in the past, it is questionable whether the Society can rely indefinitely upon increasing membership to relieve the financial stress. It seems logical that future membership campaigns might not yield as high returns as those during the past two years. Also, the rising cost of the JOURNAL is consuming an ever-increasing portion of the total dues receipts. Thus, in 1942, the cost of the JOURNAL per member was $2.12, as compared with $3.50 per member six years later in 1948. Furthermore, the routine task of servicing the enlarged membership—the dues notices, dues receipts, changes of address, preparation of the *Yearbook*, etc. —adds to the burden of an already overworked headquarters staff.

It has always been the policy of the Society to operate with a small headquarters staff on a "decentralized" plan, whereby the Divisions, Sections, and Committees handle much of their routine business. The headquarters then assumes responsibility for the national affairs of the Society, including the membership records, the editing of the JOURNAL, the arrangements for the Annual Meeting, and the maintaining of close liaison with the various Councils, Divisions, Sections, and Branches of the Society. The headquarters is also called upon to handle special projects which are frequently undertaken by the Society. Under this basic plan of operation, it has thus far been possible to handle the business of the Society with two office secretaries to assist the Secretary of the Society. This, in turn, has made it possible to operate successfully with a dues structure of from $5.50 to $7.00, which is approximately one-third that of other national engineering societies. However, under this plan of operation, the Society cannot hope to offer extensive collateral services comparable to those of other engineering societies. If the Society should attempt to duplicate these collateral services, it would inevitably require a considerable expansion of the headquarters staff, with a consequent increase in overhead and higher dues.

If the Society is to continue to operate with a small headquarters staff and still

accomplish its high objectives, it would seem necessary to concentrate the major attention upon those projects which contribute directly to the primary objectives of the Society—"the advancement of education in all of its functions which pertain to engineering and allied branches of science and technology" while at the same time subordinating the collateral benefits which burden the headquarters staff but contribute only marginally to the primary objectives of the Society.

The Secretary wishes to acknowledge the helpful assistance of the officers of the Society who have given generously of their time and effort in order to assure successful operation of the affairs of the Society. Your President and other officers were in frequent attendance at Section meetings throughout the country.

Respectfully submitted,

ARTHUR B. BRONWELL,
Secretary

June 24, 1949

Sections and Branches

The **Michigan Section** of the A.S.E.E. held its Annual Meeting on May 7, 1949 at Michigan State College. L. G. Miller welcomed the group.

At the General Session, C. L. Brattin, Chairman, appointed the following committees:

Nominating Committee: R. H. Schoonover, C. A. Brown, F. L. Schwartz, F. J. Budde and L. L. Henry.

Resolutions Committee: A. R. Carr, R. H. Spahr and H. E. Mayrose.

C. L. Allen gave a brief talk on eleven challenges which lie ahead in Engineering Education. This was followed by an address by J. W. Parker, of the Detroit Edison Company, entitled "Education for a Profession."

Officers nominated and unanimously elected for the coming year were: Chairman: H. M. Hess; Vice Chairman: H. M. Dent; Secretary-Treasurer: W. P. Godfrey.

The evening's speaker was C. J. Freund, President, A.S.E.E., who spoke on "Partnership With Industry."

The Meeting was adjourned with the reminder that the 1950 Meeting would be held at Wayne University.

The Annual Meeting of the **Pacific Northwest Section** of the A.S.E.E. was held June 16 and 17 on the campus of Montana State College at Bozeman, Montana. F. A. Thomsom presided over the First Session which included a number of institutional reports. C. A. Mockmore spoke on "A Decade of Experience with E.C.P.D." and A. E. Adami presented a paper on "A Field Course in Plance Surveying." H. E. Wessman presided over the Second Session and A. S. Janssen over the Third, which included the two papers, "Departmental Organization" by S. H. Graf and "A Coordinated Program for Engineering Graduate Research in the Northwest" by F. D. Farquharson. In the Fourth Session, K. Doane, P. Mann, R. B. VanHorn and B. T. McMinn participated in a "Symposium on Work Load Evaluation of Engineering Faculty." G. W. Gleeson presided. The Fifth Session contained a series of Departmental Group Meetings, and was followed by a dinner presided over by E. W. Schilling. R. R. Renne gave an address of welcome.

Officers were elected as follows: Chairman—A. S. Janssen; Vice Chairman—C. L. Reiser; Secretary—P. Mann.

Since the National Meeting will be held in Seattle next year, no Section Meeting is planned. The 1951 Meeting will be held at the University of Idaho.

Report of the Treasurer, 1948-49

Evanston, Illinois
July 15, 1949

Mr. James S. Thompson, Treasurer
American Society for Engineering Education
White Plains, N. Y.

Dear Mr. Thompson:

In accordance with your instructions, we have examined the accounts and records of the American Society for Engineering Education for the year ending June 30, 1949, and submit herewith the following statements prepared therefrom:

Exhibit I—Comparative Balance Sheets
Exhibit II—Comparative Statements of Changes in Funds
Exhibit III—Comparative Statements of Income and Expense
Exhibit IV—Comparative Statements of Receipts and Disbursements

In connection with the statements as of June 30, 1949, we examined and tested the accounting records, traced the receipts as recorded to deposit, checked the disbursements, counted the securities on hand, and secured direct confirmation for all funds or securities in the hands of outside parties. Our examination was made in accordance with generally accepted auditing standards and included all procedures which we considered necessary in the circumstances.

As was noted in our report last year, placing the records of the Society on the basis of a fiscal year ending June 30 resulted in the 1948 statements being prepared for a 12½ month period. This also resulted in the inclusion in the 1948 statements of the expenses of two annual meetings, as the 1947 statements were prepared prior to the annual meeting and the 1948 statements after the annual meeting.

In our opinion these statements fairly present the position of the Society at June 30, 1949, and the results of its operations for the period then ended.

Yours truly,

(Signed) Ernest C. Davies
Certified Public Accountant

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

COMPARATIVE BALANCE SHEETS

	June 30, 1948	June 30, 1949
Assets		
Current Fund:		
Cash in State Bank & Trust Co.	$37,175.25	$38,512.44
Cash in Mellon National Bank	———	689.42
Petty Cash Fund	300.00	300.00
U. S. Government Bonds Series G	20,700.00	20,700.00
	$58,175.25	$60,201.86

	June 30, 1948	June 30, 1949
Life Membership Fund:		
Cash—Checking	$ 104.18	$ 129.70
U. S. Government Bonds Series G	1,000.00	1,000.00
	$ 1,104.18	$ 1,129.70
B. J. Lamme Fund:		
Cash—Checking	$ 335.89	$ 335.89
Principal Cash in Hands of Trustee	847.67	9.00
Securities and Mortgages	4,296.58	5,132.73
	$ 5,480.14	$ 5,477.62
Accounts Receivable:		
Advertising	$ 1,976.97	$ 1,855.00
Less: Reserve for Bad Debts	—	315.00
	$ 1,976.97	$ 1,540.00
Dues	1,800.00	1,200.00
Westinghouse Educational Foundation	159.58	109.58
Income Cash in Hands of B. J. Lamme Fund Trustee	116.11	110.71
	$ 4,052.66	$ 2,960.29
Inventory (Nominal)	$ 1.00	$ 1.00
Furniture and Fixtures (Nominal)	$ 748.78	$ 748.78
Total Assets	$69,562.01	$70,519.25

Liabilities

	June 30, 1948	June 30, 1949
Current Liabilities		
Accounts Payable—Publications	$ 1,368.27	$ 1,600.00
Other Accruals	—	105.86
	$ 1,368.27	$ 1,705.86
Prepaid Membership Dues	$ 1,178.75	$ 1,099.75
Funds:		
Life Membership Fund	$ 1,104.18	$ 1,129.70
B. J. Lamme Fund	5,596.25	5,477.62
General Education Board Southeast Section	17,450.00	14,950.00
Carnegie Corporation—Eng. Salary Survey	5,730.72	4,745.21
	$29,881.15	$26,302.53
Surplus—General Fund	$37,133.84	$41,411.11
Total Liabilities and Surplus	$69,562.01	$70,519.25

COMPARATIVE STATEMENT OF CHANGES IN FUNDS

	12½ Months Ended June 30, 1948	12 Months Ended June 30, 1949
GENERAL EDUCATION BOARD, S.E. SECTION		
Balance at Beginning of Period	$10,000.00	$17,450.00
Add: Contribution during the Period	10,350.00	———
	$20,350.00	$17,450.00
Less: Charges during the Period	2,900.00	2,500.00
Balance at End of Period	$17,450.00	$14,950.00
CARNEGIE CORPORATION, ENGINEERING SALARY SURVEY		
Balance at Beginning of Period	$ 6,000.00	$ 5,730.72
Add: Transfer to General Fund	———	269.28
	$ 6,000.00	$ 6,000.00
Less: Charges during the Period	269.28	1,254.79
Balance at End of Period	$ 5,730.72	$ 4,745.21
SURPLUS, GENERAL FUND		
Balance at Beginning of Period	$32,798.53	$37,133.84
Add: Income credited to Lamme Fund in 1948 instead of General Fund	———	116.11
Summer School Fund previously independent of General Fund	———	689.42
Excess of Income over Expense for the Period	$ 4,335.31	$ 3,741.02
	$37,133.84	$41,680.39
Less: Transfer Charge from Carnegie Corporation Salary Survey	———	269.28
Balance at End of Period	$37,133.84	$41,411.11

COMPARATIVE STATEMENT OF INCOME AND EXPENSE

	12½ Months Ended June 30, 1948	12 Months Ended June 30 1949	1949–50 Budget
Income:			
Current Dues—Individual	$30,825.44	$33,145.83	$34,600.00
Institutional	6,500.00	6,862.50	6,900.00
Back Dues	586.50	———	———
Sale of Publications	1,760.12	1,793.78	1,800.00
Advertising	6,870.70	8,354.68	8,700.00
Refunds	319.64	74.89	———
Interest on Government Bonds	417.50	542.50	530.00
Miscellaneous	.77	———	———
E.C.R.C. (Sale of E.C.R.C. Publications)	2,333.38	2,053.94	———
Income—B. J. Lamme Fund	———	110.71	———
Total Income	$49,614.05	$52,938.83	$52,530.00

Expense:	12½ Months Ended June 30, 1948	12 Months Ended June 30 1949	1949–50 Budget
Cost of Publications	$18,024.87	$20,542.29	$23,000.00
Administrative Salaries	9,302.61	9,545.40	10,600.00
Retiring Emeritus	653.33	1,360.00	1,360.00
Officers' Traveling Expense	639.90	825.85	1,200.00
Travel, Secretary's Office	640.70	788.47	900.00
Postage, Telephone, and Telegraph	1,794.29	1,816.19	1,800.00
Supplies and Sundry Printing	1,537.32	2,177.45	2,200.00
Cost of Moving Secretariat	3,138.99	—	—
Dues—American Council on Education	100.00	100.00	100.00
Contribution to E.C.P.D.	500.00	500.00	500.00
Provision for Bad Debts	—	315.00	—
Expense 1947 Meeting	1,535.41	—	—
Expense 1948 Meeting	1,317.02	—	—
Expense 1949 Meeting	—	2,040.78	—
Expense 1950 Meeting	—	—	2,000.00
Expense E.C.A.C.	1,119.14	398.77	2,200.00
Expense E.C.R.C.	3,018.78	7,051.08	3,350.00
Committees and Conferences	590.81	187.06	1,000.00
Expense—Lamme Trust Fund	566.33	239.03	—
Contingencies and Special Projects	799.24	1,010.44	1,200.00
Total Expense	$45,278.74	$49,197.81	$51,410.00
Excess of Income over Expense	$ 4,335.31	$ 3,741.02	$ 1,120.00

COMPARATIVE STATEMENT OF RECEIPTS AND DISBURSEMENTS

	12½ Months Ended June 30, 1948	12 Months Ended June 30, 1949
Balance on Hand at Beginning of Period	$31,582.28	$37,175.25
Receipts:		
Current Dues—Individual	$28,474.94	$31,666.58
Institutional	6,375.00	6,662.50
Back Dues	1,586.50	1,100.50
Dues in Advance	1,178.75	1,099.75
Sale of Publications	1,760.12	1,915.75
Advertising	6,393.73	8,354.68
Interest on Bonds	417.50	542.50
Income—B. J. Lamme Fund	—	113.87
Refunds	319.64	74.89
Miscellaneous	.77	—
Westinghouse Educational Foundation	250.00	250.00
General Education Board, SE Section	10,350.00	—
Funds transferred from E.C.R.C.	2,333.38	2,053.94
Summer School transferred to General Fund	—	689.42
Total Receipts	$59,440.33	$54,524.38

	12½ Months Ended June 30, 1948	12 Months Ended June 30, 1949
Disbursements:		
Cost of Publications	$19,287.98	$20,310.56
Administrative Salaries	9,302.61	9,545.40
Retirement Emeritus	653.33	1,360.00
Travel, Secretary's Office	640.70	788.47
Officers' Traveling Expense	639.90	825.85
Postage, Telephone, and Telegraph	1,794.29	1,776.72
Supplies and Sundry Printing	1,537.32	2,177.45
Cost of Moving Secretariat	3,138.99	———
Dues—American Council on Education	100.00	100.00
Contribution E.C.P.D.	500.00	500.00
Expenses 1947 Meeting	369.16	———
Expenses 1948 Meeting	1,317.02	———
Expenses 1949 Meeting	———	1,989.39
Expenses E.C.A.C.	1,119.14	398.77
Expenses E.C.R.C.	3,018.78	7,051.08
Committees and Conferences	,590.81	472.06
Westinghouse Award	302.48	200.00
Expense—B. J. Lamme Fund	566.33	236.79
Contingencies Expense	799.24	575.42
Expense—Carnegie Survey	269.28	1,254.79
Award General Education Board	2,900.00	2,500.00
Purchase of Government Bonds	5,000.00	———
Special Project Expense	———	435.02
Total Disbursements	$53,847.36	$52,497.77
Balance on Hand at End of Period:		
State Bank and Trust Company—Checking	$37,175.25	$38,512.44
Mellon National Bank—Savings	———	689.42
Total Balance on Hand	$37,175.25	$39,201.86

Respectfully submitted,

JAMES S. THOMPSON,
Treasurer

Deaths During 1948-49

Adams, O. L.
Berry, G. M.
Boase, A. J.
Bodman, E. P.
Brule, C. G.
Campbell, W. B.
Eames, Jesse J.
Ebaugh, W. C.
Focke, T. M.
Forman, A. H.
Gately, E. R.
Gould, Archie B.
Greene, John W.
Hall, Philip R.
Hook, Warren H.
Houser, Shaler C.
Hutchinson, R. C.
Lear, John E.
Lilly, Scott B.
Locke, Chas. E.
Lynn, A. J.
Roehrig, G. F.
Seamon, W. F.
Seegrist, W. H.
Simon, Arthur
Wilson, William
Woodbury, C. V.
Work, W. R.
Wright, R. V.

There were 162 resignations during the 1948–49 fiscal year.

Annual Report of Manpower Committee

This report was prepared by a subcommittee composed of Messrs. Armsby, *Chairman,* Dawson, Hollister, and Saville. The subcommittee assumed full responsibility for the report, which has not been submitted to the full committee.

The Manpower Committee of ASEE, originally appointed by the President, whose previous reports have been published in the issues of the JOURNAL OF ENGINEERING EDUCATION dated October 1947 and September 1948, was reappointed in the fall of 1948 by the President of the Engineering College Administrative Council. Close contact has been maintained during the year with the General Survey Committee of the Engineers' Joint Council, and with the Bureau of Labor Statistics of the U. S. Department of Labor.

A subcommittee (composed of Messrs. Trytten, Chairman, Armsby, and Goldstein) has conferred with officials of the Census Bureau, with the Bureau's Interdepartmental Advisory Committee, and with the National Resources Planning Board, and has made recommendations to these groups that several new categories be added to those formerly employed in the National Census for designating people working in the fields of the sciences and of engineering, and that college teachers be subdivided according to their specialty rather than all being counted simply as teachers. It is the hope of the subcommittee that these changes will be incorporated into the 1950 census. If so, they should help to obtain a better base for future studies.

Future Supply of Engineering Graduates

The Compton and Armsby reports in 1946, and previous reports of this Committee, based predictions of numbers of graduates on pre-war mortality rates. There is evidence indicating that current mortality rates are higher than those prevailing in pre-war years. The Armsby report in 1946 predicted 38,000 graduates for the school year 1947–48. An estimate by the Committee in the fall of 1947 reduced this to 31,000. The February issue of the *ASEE Journal* reported 27,000 graduates, a decrease of nearly 25 per cent from the estimate made in the fall of 1946. This increased mortality is probably due to increased economic pressure on veterans, coupled with the fact that many veterans have learned that they are not adapted to the engineering curriculum to which they were attracted by war experiences. Presumably attrition rates will return to normal in the near future.

It should be pointed out that the ASEE reports on enrollments and degrees do not include all college students who are pursuing engineering curricula. The latest ASEE enrollment report lists 147 colleges, and reports enrollments and degrees granted in 144 of them. Included in the list are ten colleges which have not been accredited in any curriculum by ECPD. The U. S. Office of Education study of degrees granted in American colleges last year lists engineering degrees conferred by 39 additional colleges. It is likely that to the general public and to many employers of engineers the recipients of these degrees are in direct competition with those graduating from the colleges listed in the ASEE report. The number of graduates from these 39 colleges is about 3000, which probably must be considered as an addition to the supply of engineering graduates previously considered by this Committee.

THE JOURNAL OF ENGINEERING EDUCATION for March 1949 contains an article by Dean S. C. Hollister of Cornell Uni-

versity entitled "Post-War Engineering Enrollment Rapidly Adjusting to Near Pre-War Level." Dean Hollister calls attention to the rapidly declining freshman classes in engineering, and indicates by careful analysis that both the freshmen entrants and the prospective degrees issued are rapidly returning to the pre-war gradient, in other words, to what we might expect they would be had there been no World War. His study confirms the opinion expressed by the ASEE Manpower Committee's 1948 report to the effect that supply and demand of engineering graduates might be expected to be in balance by 1951.

Dean Hollister's predicted graduation figures (40 thousand in 1949, 40 thousand in 1950, and 31 thousand in 1951) are slightly less than would be obtained by applying pre-war mortality rates to last fall's enrollment figures as reported in the *ASEE Journal,* and do not include graduates of the unaccredited colleges just mentioned, which might increase the number of graduates by 10 per cent.

Certain factors might be mentioned which may be expected to operate in the direction of increasing engineering enrollments still further. Among these factors are (a) the rapid and continuing increase in the percentage of college-age youth who attend college; (b) the effects of the G. I. Bill, not merely on the veterans themselves, but on their friends and relatives; (c) the report of the President's Commission on Higher Education; (d) new scholarship programs, such as the N.R.O.T.C. and the proposed programs of the Army and the Air Forces, the proposed establishment of a National Science Foundation, and the possible establishment of a general program of Federal Scholarships; and (e) the possible establishment of engineering curricula in additional colleges. However, it is the feeling of the subcommittee that in spite of these factors tending to increase engineering enrollment, the number of engineering graduates in the next two years can be expected to be appreciably smaller than previously estimated by the Committee, but much larger than the pre-war gradient figures.

Demand for Engineering Graduates

The Bureau of Labor Statistics estimates an *average* annual need for engineering graduates of between 17 and 18 thousand during the early part of the next decade, increasing to an annual demand of about 21 or 22 thousand by 1960. This estimate is based on actual numbers of engineers needed for engineering jobs, including anticipated expansions and the three kinds of attrition caused by death, retirement, and leaving the profession, but making no allowance for the fourth kind of attrition which affects an individual company without entering into the national picture--namely, that due to men transferring from one company to another.

The E.J.C. survey shows that 162 industrial firms and 31 State and governmental agencies which now employ 89 thousand engineers (out of a total of 4 million employees) hired some 10 thousand inexperienced graduate engineers in 1948, and that they expect to hire 8 thousand in 1949, a decrease of 21 per cent. The engineers now employed in these companies and agencies are estimated to constitute approximately one-third of all employed engineers in the country. If the same ratio of new engineers to engineers now employed prevails in the remaining industries and agencies of the country, this would indicate that some 31 thousand engineers were hired in 1948, which number would be reduced to 24 thousand in 1949. The Bureau of Labor Statistics has attempted to make a more accurate extrapolation of the E.J.C. figures, industry by industry, and has arrived at an estimate of 27 thousand for 1948 and 21 thousand in 1949, excluding government agencies and the construction industry, in which they felt the E.J.C. samples were not representative. In other words, there is no significant difference between the results of the two methods of extrapolation of the E.J.C. sample.

It should be noted however, that these

estimates, based on judgments of industrial and governmental employment officials, of necessity include allowances for the fourth kind of attrition, the kind caused by men transferring from one company to another. Just how much duplication this introduces into an estimate of national need is not known, but certainly it is an important factor. The subcommittee hopes that future studies can be formulated in such a way as to secure some valid information on this important aspect of the manpower situation.

On the other hand, all of these estimates are concerned with actual present or definitely foreseen short term needs for engineering graduates to fill engineering jobs, and do not sufficiently reflect the well-known fact that many engineering graduates find employment in non-engineering work, especially in administrative or technical sales positions. Nor do they, in the opinion of the subcommittee, make sufficient allowance for the fact that engineering is still a growing and expanding profession.

Previous reports of this Committee have pointed out that not only the total number of engineers but also the ratio of engineers to total employment has been steadily rising ever since employment statistics have been assembled. Many factors operate toward a continuation of this increase in the ratio of engineers to total employment. Among these are: (a) the great increase in the use of engineers by government agencies, particularly the Armed Forces; (b) the continually increasing complexity of technology; (c) the effect of war-time experiences which demonstrated the value, and in many cases the absolute necessity, of engineering services; (d) the continually increasing intensity of competition in business, which creates a need for continually increasing efficiency in the use of manpower, materials, power, and equipment; (e) the continually increasing need for and use of research by industry and government; and (f) the "yeastiness" of the profession —the tendency for engineers to develop new processes and services which create needs for new kinds of engineers and technicians, such as the recent developments in radio and electronics applications, plastics and other chemical products, and the rapidly unfolding field of utilization of atomic energy.

All these factors and others result in what might be called the "horizontal spread" of the use of engineers into additional industries, particularly small industries, as well as the "vertical spread" within industries previously using engineers, and combine to greatly increase the demand for engineers.

Thirty-one thousand, the estimated hirings for 1948, is just the number of engineering graduates reported in the U. S. Office of Education study of degrees. Twenty-four thousand, the number of hirings indicated for 1949, is considerably less than the probable number of engineers who will be graduated in 1949. These figures, based on estimates of industrial and governmental employment officials, would seem to indicate a surplus of some 16 thousand engineers this year, but it is the firm conviction of the subcommittee, based on opinions of college officials, that no such surplus exists. No actual statistics are at hand, but consultations with deans of engineering in many parts of the country indicate that by and large the graduates of this year will be placed at the time of graduation or soon thereafter. No information is at hand as to the number who will be placed in non-engineering positions. The general picture seems to be that placement of graduates is slower than it has been for the past few years, and that the boys are not getting as many offers among which they may choose, but very few engineering deans expect any real difficulty in placing their graduates this year. It seems therefore that all of our estimates of demand must be increased over previous estimates made by this Committee.

General Conclusions

It seems probable, in view of the present large junior and sophomore classes, that students graduating from engineer-

ing colleges during the next two years may not all be immediately absorbed in engineering positions, that during the two years there may be a temporary excess of graduates over immediately available engineering positions of perhaps two-thirds of a year's normal supply. However, the subcommittee submits that there is a possibility that some of the factors which have been mentioned may operate to increase the demand to the point where there will be little or no excess.

Even if a temporary excess does develop, the subcommittee feels that there is no cause for great alarm in the situation. Engineering education has long been recognized as having great value as general education and as a good foundation for work in many professions other than engineering. The engineer's training in careful, thorough, accurate work, and in the scientific method of thought has been found useful in dealing with problems of human relations as well as with problems of utilizing the materials and forces of nature, and it is our belief that boys graduating in engineering during the next few years can expect to find employment, if not in strictly engineering work, at least in some activity in which their scientific training will not be wasted.

The question has been raised in many quarters as to whether or not we are educating in America too many engineers, too many lawyers, too many business men, and if the current and proposed increase in the number and proportion of college graduates will create a social unrest and widespread personal disappointment and sense of frustration. The committee feels that the answer to this problem has been well stated in the report of the President's Commission on Higher Education. In a recent address before the faculty of the State Teachers College at Indiana, Pennsylvania, Dr. John Dale Russell, Director of the Division of Higher Education of the U. S. Office of Education, said "The discussion in that report should allay the fears that anyone may have regarding the possibility of over-educating American youth. As long as there is adequate attention to a sound general education, and as long as the occupational or professional education is accompanied by adequate guidance and counselling, the likelihood of any serious overproduction of college preparation seems remote."

However, the subcommittee feels very strongly that the situation calls imperatively for increased emphasis on adequate programs of selection and guidance of engineering college students, so that they may understand the requirements of the profession, the employment opportunities in it, and the possibilities of utilizing an engineering education as a foundation for non-engineering activities.

The last annual report of this Committee recommended "that steps be taken to secure funds so that a carefully laid plan, to develop techniques and methodology, be established in order to secure reasonably accurate and complete statistical information, and that a full-time consultant or statistician be employed to make this complex and difficult survey in that we are confident that it is impossible to make an effective presentation of the facts by the utilization of voluntary personnel of the Society." Since that time, the Bureau of Labor Statistics' report on the Employment Outlook for Engineers has made it evident that this Bureau's studies have gone much further and been more explicit and productive than the preceding studies of the Manpower Committee. The subcommittee therefore recommends that the Manpower Committee be continued as a permanent committee of the Society to work in close liaison with the U. S. Bureau of Labor Statistics.

THE MANPOWER COMMITTEE:

H. H. ARMSBY	S. C. HOLLISTER
M. M. BORING	R. M. KIMBALL
M. T. CARPENTER	C. T. REID
F. M. DAWSON	THORNDIKE SAVILLE
O. W. ESHBACH	W. W. SQUIER
E. P. HAMILTON	T. A. H. TEETER
E. V. HOLLIS	M. W. TRYTTEN

L. M. K. BOELTER, *Chairman*

Minutes of Executive Board Meeting

A meeting of the Executive Board of The American Society for Engineering Education was held on Monday, June 20, 1949, at Rensselaer Polytechnic Institute. Those present were: C. J. Freund, President, F. M. Dawson, B. J. Robertson, Thorndike Saville, S. S. Steinberg, J. S. Thompson, A. B. Bronwell, J. I. Mattill (guest) and D. Daum.

Report of Secretary

The Secretary announced that his written report summarizing the year's activities would be published in the September issue of the JOURNAL. He reported that the membership campaign had resulted in over 1000 new members again this year, of which 122 were industrial executives. A number of university and college presidents have recently joined the Society.

Report of Treasurer

The Treasurer presented the auditor's report as of May 31, 1949. He announced that the Faculty Salary Study Committee account would be closed out shortly after July 1 of the coming year, and that the Southeastern Section is making application for an extension of their research grant.

The Board voted unanimously to authorize the Treasurer to invest $10,000 in the purchase of government bonds.

The Board passed a motion to approve the proposed budget for 1949–50. This budget will be published in the September issue of the JOURNAL.

Appointment of Representative to Pan American Conference

The Board unanimously passed a motion appointing Dean S. S. Steinberg the official representative of the ASEE at the Pan American Engineering Congress to be held in Rio de Janeiro, Brazil, July 15 to 24, 1949. Dean Steinberg's expenses in connection with attending this Congress will be paid by the Brazilian government.

Report of ECAC

Dean Steinberg, Vice-President in charge of the ECAC, reported briefly on the activities of the ECAC. He announced that new by-laws had been approved by the ECAC and the Committee on By-Laws of the Society.

He also announced completion of reports by the following committees:

1. Committee on Engineering Building Survey
2. Faculty Salary Study Committee
3. Manpower Committee
4. Secondary Schools
5. Committee on Military Affairs

These reports were presented at the ECAC General Session. He also stated that the Executive Committee of the ECAC was considering the feasibility of making a new general survey of engineering education, similar to the Wickenden report.

Report of ECRC

Dean Dawson, Vice-President in charge of the ECRC, reported that the 1949 edition of the "Review of Current Research and Directory of Member Institutions" had been completed, and was available for distribution. In the past six months, eight engineering colleges have become members of the ECRC. Also, the Research Council has completed publication of a booklet "Telling the Story of Engineering Research."

1950 and 1951 Annual Meetings

President Freund announced that the annual meeting would be held during the

week of June 19 to 23, 1950, at the University of Washington.

It was moved and seconded to accept the invitation of Michigan State College to hold the annual meeting in 1951 on their campus. The Board recommended that this invitation be presented to the General Council for their approval at the Council meeting on Monday evening.

Fall Meetings, ECAC, ECRC, and General Council

In view of recent correspondence with the Engineering Division of the Land Grant College Assn., the Board voted to accept their proposal to hold meetings of the ECAC, ECRC, Executive Board and General Council on October 28, 1949, at Kansas City, Mo., following the Land Grant College meetings.

James H. McGraw Award

It was voted to recommend to the General Council that the Society accept the proposal for a James H. McGraw Award as outlined in a letter from Mr. Booher of McGraw-Hill Book Company to Mr. Rodes of the Technical Institutes Division, if the proposal be made in writing by the McGraw-Hill Book Company directly to the Society, provided that the Society does not incur any financial obligation in connection with the Award, and subject to the right of the Society to terminate the Award on one year's notice.

An additional motion was passed to recommend to the Council that this Award be handled by the Technical Institutes Division and that the Award be made by and presented at a meeting of the Technical Institutes Division, under conditions to be set by that Division with the approval of the Executive Board.

The above motions were approved, J. S. Thompson not voting.

Publication of the Yearbook

It was moved and seconded that the question of publishing the *Yearbook* in alternate years only be deferred to the next meeting, pending a report and cost estimate from the Secretary on the possibility of reducing the size of type in the *Yearbook* and using two columns to the page.

Applications for Institutional Membership

The following applications for institutional membership in the Society were approved:

Affiliate institutional membership: Academy of Aeronautics, N. Y.; Northrop Aeronautical Inst., Calif.

Associate institutional membership: Tau Beta Pi Assn., Tenn.

Appointment of Secretary

The Board unanimously voted to reappoint Arthur B. Bronwell Secretary of the Society for the year 1949–50.

Distribution of Reports

The Board voted that the Society's policy regarding the distribution of reprints of published reports would be that members may receive one copy of any such reports upon request, but that a charge would be made for additional copies or reprints, the Secretary to determine the amount of the charge in each case.

Speaker's Manual

It was voted to recommend to the General Council that the ECPD be given an opportunity to sponsor jointly the manual "Speaking Can Be Easy," prepared by the Committee on Relations with Industry, if they are interested in this project.

Minutes of General Council Meetings

A meeting of the General Council of the American Society for Engineering Education was held on Monday, June 20, 1949, at the Troy Country Club. Those present were: C. J. Freund, President, M. T. Ayers, G. J. Barker, H. W. Barlow, L. R. Blakeslee, A. B. Bronwell, C. A. Brown, L. E. Conrad, H. O. Croft, D. Daum, F. W. Dawson, M. E. Farris, L. E. Grinter, R. P. Hoelscher, H. K. Justice, W. A. Koehler, F. T. Mavis, O. N. Olson, O. E. Osburn, G. K. Palsgrove, James G. Potter, H. S. Rogers, B. J. Robertson, Thorndike Saville, F. L. Schwartz, S. S. Steinberg, O. M. Stone, J. T. Strate, F. E. Terman (representing E. L. Grant), J. S. Thompson, J. E. Thornton, J. K. Walkup, C. Wandmacher, W. C. White, J. B. Wilbur, J. H. Zant. Invited guests present were: N. W. Dougherty, J. P. Hammond, L. W. Houston, Nell McKenry, L. G. Miller and F. H. Rhodes, Jr.

President Houston welcomed the officers and members of the Society to the Rensselaer campus, and gave a brief history of the founding of Rensselaer Polytechnic Institute and the part it played in the development of engineering education in this country.

Committee on Aims of Engineering Instruction

Dean Hammond presented a proposal for a committee of the Society to study the aims of engineering instruction. The committee would study the effectiveness of various teaching methods, with particular reference to those methods which would increase the student's participation in his own learning process and which would develop to a higher degree the ingenuity, originality, and creative ability of the student. It was voted that copies of Dean Hammond's proposal be mimeographed and made available to members of the Council for further study, and that this question be taken up again at the Friday morning (June 24) Council meeting.

1950 and 51 Annual Meetings

President Freund announced that the dates of the 1950 annual meeting at the University of Washington would be June 19–23. Dean Miller of Michigan State College presented an invitation to hold the 1951 annual meeting during the week of June 25–29 at Michigan State College. The Council voted to accept this invitation for 1951, the exact dates to be determined later.

Secretary's Report

Copies of the Secretary's report were distributed to Council members, and the Secretary commented briefly on the Society's activities during the year.

Report of Treasurer

The Treasurer presented the auditor's report as of May 31, 1949, and announced to the Council that the Board had voted to invest $10,000 in government bonds. Copies of the budget approved by the Board for 1949–50 were distributed to the Council, and this budget will be published in the September issue of the JOURNAL.

Amendments to the Constitution

Professor Croft, Chairman of the Committee on Constitution and By-Laws, presented the proposed amendments to the Constitution. After some discussion, a straw vote was taken on the proposed amendment to present Article XI, Section 2, to determine whether the nominating committee should include the retiring Council members representing both Divisions and Sections or only those repre-

senting Sections. It was voted that this proposed amendment should specify that both Division and Section representatives be included on the Nominating Committee.

The amendments submitted by the Committee on Constitution and By-Laws, as revised by the above vote, were approved. These amendments will be submitted to the general membership of the Society for final vote.

Provisional Division Status for Committee on Relations with Industry

The Council voted to grant Division status to the Committee on Relations with Industry, subject to approval of the proposed Constitutional Amendments by the Society membership.

Report on Activities of Divisions and Committees

Vice-President Saville presented a brief report on the activities of the Divisions and Committees. He pointed out that the chairmen of the various Divisions and Committees were kept informed of activities of the Society through circular letters. He reemphasized the need for Committees and Divisions giving consideration to initiating long-range projects which will contribute to the fundamental objectives of the Society.

Report on Sections and Branches

Vice-President Robertson presented a brief report on activities of Sections and Branches, indicating that several new branches have been established where needed. It was voted to approve the requests of the University of Arkansas to join the Missouri Section, and of the University of Utah and Utah Agricultural College to join the Rocky Mountain Section.

Measurement and Guidance Project.

President Rogers presented a progress report of the Measurement and Guidance Project now being administered by the Educational Testing Service. He stated that, as presently constituted, there appears to be little likelihood that the project can be put on a self-financing basis and that some form of reorganization may be necessary. One proposal being considered is that of merging the Measurement and Guidance tests with the College Entrance Board tests.

Journal

The Secretary reported that many favorable comments have been received on the new cover layout and format of the JOURNAL. The possibility of achieving an economy by publishing the *Yearbook* in smaller type size was suggested by the Treasurer and will be investigated. The inclusion of a page in each issue of the JOURNAL giving the dates and location of Section meetings has proven of considerable value and will be continued. Also a page will be set aside in each issue for the use of Divisions. No increase in printing costs is anticipated for the coming year, although a bill now before Congress would increase the cost of postage rates, and add about $2300 to the cost of mailing the JOURNAL.

Section Rebates

The question of increasing the membership dues and making corresponding rebates to Sections was raised. It was pointed out that most Sections have only one meeting a year and that the operating costs are consequently relatively small and are usually carried either by the host institution or by a slight increase in the cost of meals. It was also pointed out that a constitutional provision specifies that Sections shall be self-sustaining, a provision which was included in order to keep the Society dues to a minimum. In view of these considerations, no action was taken on the proposal.

The Council meeting was adjourned and the other items on the agenda were deferred until the Friday morning meeting on June 24.

* * *

MEETING, JUNE 24, 1949

A breakfast meeting of the old and new members of the Council was held on Fri-

day, June 24, 1949, at the Hendrick Hudson Hotel, Troy, New York. Those present were:

C. J. Freund, President, H. H. Armsby, M. T. Ayers, H. W. Barlow, H. R. Beatty, C. E. Bennett, A. B. Bronwell, C. A. Brown, L. E. Conrad, D. Daum, F. M. Dawson, M. E. Farris, L. E. Grinter, G. B. Hoadley, R. P. Hoelscher, W. L. Hughes, H. K. Justice, W. A. Koehler, J. H. Koffolt, R. D. Landon, L. J. Lassalle, F. J. Lewis, G. D. Lobingier, E. R. McKee, O. N. Olson, O. E. Osburn, G. K. Palsgrove, J. G. Potter, B. J. Robertson, M. B. Robinson, Thorndike Saville, S. S. Steinberg, O. M. Stone, J. T. Strate, J. S. Thompson, J. E. Thornton, C. Wandmacher, W. C. White, R. Z. Williams, J. H. Zant. Invited guests present were: H. P. Hammond, Nell McKenry and F. H. Rhodes, Jr.

Life Membership

The following applications for life membership were approved, and the Secretary was instructed to notify these members of this action:

Robert M. Black	Almonte C. Howell
James E. Boyd	L. L. Patterson
John A. Ely	O. W. Silvey
Leroy S. Foltz	

Delinquent Members

The Secretary was authorized to drop from membership in the Society those who are in arrears more than two years in dues.

Committee on Ethics of Interviewing Procedures

It was voted that when the Committee on Relations with Industry becomes a Division as provisionally voted at the Monday Council meeting, then the Committee on Ethics of Interviewing Procedures shall become a subcommittee of the Division on Relations with Industry.

Committee on Aims of Engineering Instruction

It was voted that the plan for a committee on aims of engineering instruction, as outlined in the letter by Dean Hammond distributed to Council members, be adopted and that a steering committee be appointed. It was further voted that this steering committee should formulate its objectives and then contact the Divisions and Committees in similar fields for nominations of additional committee members. Additional appointments would then be made to the enlarged committee by the President of the Society and this committee would then become a committee of the Society. It was suggested that the Council members write to President-elect Saville informing him of any suggestions they might have for the membership of this committee.

Professor Grinter reported that he will be writing to the President proposing a similar committee to work on graduate study.

Enrollment Statistics

The Council voted to approve an agreement with the U. S. Office of Education, whereby the Society and the Office of Education will work jointly in the collection and tabulation of engineering enrollment statistics. The tabulation will be handled by the U. S. Office of Education. This agreement was previously approved by the Executive Board of the ASEE and the Office of Education.

Summer Schools

President-elect Saville announced that plans for future summer schools would be discussed at the meeting of Division and Committee Chairmen to be held later in the day, in order to obtain advance planning and better organization of the summer schools.

Technical Institute Award

The Executive Board's recommendations regarding the James H. McGraw Award, recommending acceptance of this Award with certain provisions, was approved by the General Council.

Geographical Rotation of Annual Meetings

The Secretary called the Council's attention to the plan for a geographical rotation of annual meetings which was adopted by the Executive Board and briefly explained the plan. This plan divides the country into six zones, based upon membership population, and assures that each zone will have an annual meeting at least once every eight years.

The Chairman of the Electrical Engineering Division commented on the conflict between the ASEE and AIEE meeting dates. Attempts are being made to minimize such conflicts wherever possible and to coordinate the meetings of engineering societies having conflicts so as to make it possible for Society members to attend meetings of more than one engineering society. However, it has been found necessary for the ASEE meetings to be held at a time which is convenient to the host institution, which is usually the third or fourth week of June since this falls between terms. There are four other major engineering societies which hold their annual meetings during these two weeks, and it appears as though a conflict is inevitable, unless one or more of the societies changes its basic plan of summer meetings. The suggestion was made that the ASEE might hold one of its annual meetings in the South at Xmas time in order to avoid such conflicts. This matter will be studied by the Executive Board.

Speaker's Manual

It was voted that the Society should approach the ECPD to determine whether or not they would be interested in jointly sponsoring the publication of the Speaker's Manual which was prepared by the Committee on Relations with Industry.

National Science Foundation Appointments

The Council voted to adopt the following resolution regarding the National Science Foundation Bill:

RESOLVED, that

WHEREAS, the engineering profession and engineering educators have a vital interest in government sponsored engineering research as embodied in the National Science Foundation Bill, and

WHEREAS, it is deemed imperative to the nation's welfare to have engineers represented on the governing board of the National Science Foundation,

THEREFORE BE IT RESOLVED, that the General Council of The American Society for Engineering Education authorize the Executive Board of this Society, in cooperation with other engineering societies, to make nominations for members of the governing board of the National Science Foundation.

The meeting was adjourned at 9:30 A.M.

Respectfully submitted,

ARTHUR B. BRONWELL,
Secretary

Fifty-Seventh Annual Meeting
American Society for Engineering Education

The Fifty-seventh Annual Meeting of The American Society for Engineering Education was held at Rensselaer Polytechnic Institute, Troy, New York, June 20–24, 1949. Over 1750 members and guests were registered, this being the largest attendance in the history of the Society. Four general sessions and approximately ninety conferences of Councils, Divisions, and Committees were held. C. J. Freund, President of the Society and Dean of Engineering at the University of Detroit, presided.

The first general session on Tuesday morning was opened by President Freund who introduced L. W. Houston, President of Rensselaer Polytechnic Institute, who welcomed the Society to Rensselaer. He spoke on administrative problems facing the universities and colleges, with particular emphasis upon the financial problems. Vice-President Robertson, as presiding officer, then introduced President Freund, who delivered the address on "Engineering Education and Freedom from Fear." A certificate was presented by E. S. Burdell to President Houston of Rensselaer Polytechnic Institute extending the Society's congratulations to Rensselaer on their 125th Anniversary. M. E. Coyle, Executive Vice President, General Motors Corporation, spoke on "Maintaining Our Industrial Leadership through Engineering."

The second general session on Wednesday morning was presided over by Vice-President F. M. Dawson, Chairman of the Engineering College Research Council, who reported on the activities of the ECRC for the year. The program featured the subject "Instrumentation for Engineering Research," with an address by G. S. Brown of the Massachusetts Institute of Technology, and other short talks on research equipment by panel speakers. An interesting demonstration of research instruments and equipment followed the General Session.

The third general session on Thursday morning was opened by Vice-President S. S. Steinberg, Chairman of the Engineering College Administrative Council. The following papers were presented:

1. Educational Testing Service—O. W. Eshbach
2. Summary Report of Committee on Manpower—H. H. Armsby
3. Engineering Mission to Latin-America—S. S. Steinberg
4. Engineering and Technical Education in Great Britain from 1929 to 1949—W. R. Woolrich
5. Report of Salary Study Committee—W. C. White

The annual dinner was held Thursday evening with President Freund presiding. The speaker was The Honorable George V. Allen, Assistant Secretary of State, who spoke on "Where Do We Stand on Point Four," with particular reference to the part which engineers will take in President Truman's proposed Point 4 Program dealing with international exchange of technical information. President Freund then introduced the officers of the Society and the chairman of the local committee. President L. W. Houston of Rensselaer Polytechnic Institute presented Freund with a gravel made from the wood of a replica of the original "Half Moon," Hendrick Hudson's famous ship.

The Lamme medal was presented to Karl T. Compton, Chairman of the Research and Development Board and

Chairman of the Board of Directors of the Massachusetts Institute of Technology, and the George Westinghouse Award to Joseph Marin, Professor of Engineering Mechanics at Pennsylvania State College.

Past President Rogers, Chairman of the Nominating Committee, presented the following slate of officers. Upon motion, they were unanimously elected.

For President, one year: Thorndike Saville, New York University.

For Vice-President in charge of instructional division activities, to fill out the unexpired term of Thorndike Saville for one year: B. J. Robertson, University of Minnesota.

For Vice-President in charge of sections and branches, two years: H. H. Armsby, U. S. Office of Education.

For Treasurer, one year: James S. Thompson, White Plains, N. Y.

At an election of the Engineering College Administrative Council, F. E. Terman, Dean of Engineering at Stanford University, was elected Vice-President of the Society in charge of the Engineering Colleges Administrative Council. The Society's Vice-President in charge of the Engineering College Research Council, F. M. Dawson, Dean of Engineering at the State University of Iowa, continues in office for another year.

President Freund announced that the 1950 annual meeting would be held at the University of Washington, June 19–23, and that the 1951 annual meeting would be held at Michigan State College.

The fourth general session on Friday was under direction of the Committee on Relations with Industry. Vice-President Thorndike Saville presided at this meeting. The following papers were presented:

1. Industry-College Relations—The Role of the Practicing Engineer—L. A. Appley
2. Industry-College Relations—The Role of the Engineering Educator—R. Walters
3. Factors Affecting Industrial Activity—C. H. Greenewalt

In addition to the general sessions and conferences, the Annual meeting included several outstanding features aimed at contributing to the advancement of engineering education. An industry-college forum, sponsored by the Committee on Relations with Industry, on the subject "Development of the Young Engineer," attended by over 200 industrialists and administrators of engineering colleges, presented nationally prominent speakers on subjects dealing with the professional development of the young engineer, licensing of engineers, and union aspects of engineering.

An unusually successful exhibit of instructional aids, arranged by a committee on Visual Aids under the Educational Methods Division, served to disseminate ideas on the application of visual aids to engineering instruction. The exhibit included many ingenious devices for illustrating fundamental principles in mechanics; devices for demonstrating field and flow patterns in complicated electric fields, magnetic fields, heat flow and fluid flow fields; devices for illustrating wave phenomena; and many other interesting exhibits, as well as films and slides on engineering subjects. This exhibit clearly demonstrated the potentialities of applying visual aids to engineering instruction and has served to stimulate increased effort in the construction and use of instructional aids. A similar exhibit is being planned for the Annual Meeting next year at the University of Washington.

Another unusual feature of the Annual Meeting was an International Night Dinner and Conference. Arranged by the Society's Committee on International Relations, this meeting was attended by over forty engineering administrators and educators from foreign countries, in addition to many U. S. members of the Society. The various foreign delegates spoke briefly upon the background and present status of engineering education in their respective countries.

The following resolution of thanks to Rensselaer Polytechnic Institute was read

at the banquet by H. W. Barlow, Chairman of the Committee, and unanimously approved by the Society:

"To the Rensselaer Polytechnic Institute and to the many local committees through which excellent arrangements were made and executed, The American Society for Engineering Education on this occasion of its Fifty-Seventh Annual Meeting wishes to express its appreciation and thanks.

"The hospitality, courtesy, and kindness of the staff members of our host institution have been thoughtful and generous; the arrangements for meetings and conferences have shown careful and efficient planning. The entertainment provided for us, our wives and families and the opportunities for us to see this beautiful and historic part of our nation will be remembered with pleasure.

"It is especially gratifying to have had the opportunity of participating in the celebration of the One Hundred and Twenty-Fifth Anniversary of engineering education at this institution.

"Grateful thanks are also extended to the industries of the regions for arranging interesting and instructive inspection trips.

"To the officers and committees of The American Society for Engineering Education who have guided so successfully this organization through the past year, and have directed its growth and substantial contributions to the education of our young people, the Society extends its highest congratulations and approval."

The annual meeting adjourned sine die to meet at the University of Washington, Seattle, Washington, June 19–23, 1950.

Respectfully submitted,

ARTHUR B. BRONWELL,

Secretary

Reserve these dates . . .

E.C.AC. and E.C.R.C. MEETINGS

Kansas City — October 28, 1949

Kansas City Municipal Auditorium, Room 600

. . . and

ANNUAL MEETING

June 19–23, 1950

UNIVERSITY OF WASHINGTON

Seattle, Washington

Principles Which Should Guide the Development of an Undergraduate Program in Engineering

By THE COMMITTEE ON UNDERGRADUATE CURRICULA

This statement has been prepared with particular reference to undergraduate curricula in Civil Engineering. It is clear, however, that the basic arguments, principles and recommendations advanced apply with equal force to all undergraduate engineering programs.

General Considerations

We believe that the following general facts must form the basis for the further development and evolution of undergraduate curricula in engineering.

1. Any satisfactory undergraduate engineering course must be planned, organized and staffed so as to blend into a well-coordinated and integrated whole, four groups of studies:

a. *General education* with special attention to the effective oral and written use of English, to awakening the students' interests in man's hopes and aspirations, his aims and his problems, as revealed in the written word, and, especially, to the part which the engineer, both as a citizen and in the interests of his profession, must play in the efforts of man to cope with the economic, social and political problems of an adaptive society in an age of ever more rapid technological change.

b. *Mathematics and natural science.* It is inevitable that undergraduate engineering education must continue to give increasing emphasis to a thorough training of the young engineer in the understanding and use of these basic tools of his profession.

The trend in engineering practice has, for close to a century, been toward the ever-increasing rationalization along mathematical and scientific lines of design techniques which formerly were based on empirical practices or rules-of-thumb. This search for the "reduction to a science" of older practices goes forward today at an ever-greater tempo.

Furthermore through research in both natural and engineering science, older understandings are being strengthened while new discoveries constantly create new techniques and avenues for further progress.

c. *Basic engineering science,* including the mechanics of materials, engineering thermodynamics, hydraulics or fluid mechanics, the principles of power machinery, and of electric machines and circuits.

These subjects are basic to any sound undergraduate program not only because they introduce the student to the viewpoint and methods of engineering (the "engineering mind"), as contrasted with natural science, not only because they find application and use in all branches of engineering, but because the young engineer frequently follows a branch of engineering other than that of his undergraduate study.

d. *Specific technological applications.* An introduction to some of the problems of application and use of the foregoing studies in a specific major field of engineering and the special practices and techniques involved. The undergraduate student cannot be left with a great collection of tools which he does not understand how to use. Some courses in specific techniques of practice are essential if his feet are to be kept on the ground.

and he is to be prepared for effective subprofessional service.

While it is true that many of the basic principles of engineering practice are common to all branches of engineering—such as chemical, civil, electrical, industrial, mechanical or mineral—a single "general engineering" curriculum based on this observation would not afford a practical and realistic solution of our present day undergraduate situation. The trend, we believe, is in this direction but these principles can be developed and the techniques of applications can be quite as effectively taught in any one of these major branches as in another and far more usefully than in a general engineering course.

We favor, therefore, the maintenance of these older and well-established divisions in this fourth group of studies. On the other hand we are opposed to any further undergraduate specialization through many options or electives because it must inevitably lead to less emphasis on the fundamentals of all engineering education comprised in groups (a), (b), and (c).

Length of Curriculum

2. Four years has been the long established period for the first or bachelor's degree. We agree that four years do not afford sufficient time if all the subjects of the older four-year curricula are to be retained in new programs which must now include due attention to the general educational group of subjects plus increasing emphasis on mathematics and science, both natural and engineering.

In our opinion, the time has arrived when we should give attention to the long-expressed viewpoint that undergraduate engineering education should be limited to fundamentals and that any marked specialization should be deferred to graduate study.

We believe that the statement cannot be disputed, that any engineering graduate who is well grounded in the fundamentals can, through self-study during his engineering apprenticeship, or through specialized post-graduate education, make good on almost any specialized branch of engineering application. On the other hand, it is very rare indeed that the student who lacks in fundamental understandings is ever able later to make good in the basic omissions of his undergraduate years.

The time has come for a complete overhauling of the traditional programs in all branches of undergraduate engineering education with more than lip service to fundamental needs and objectives in mind.

Specific Recommendations

3. In order to make effective the above proposals it will be necessary to eliminate from undergraduate curricula a number of subjects which, in the past, have been considered as "something the young engineer could not do without." Many engineering teachers have devoted their careers to, and achieved their reputations as experts in some of these more highly specialized—and too often largely descriptive—subjects. Many of them constitute excellent vehicles of engineering education. Yet as we have said, four years should be long enough for a sound, fundamental engineering course—to make it so, eliminations in group (d) must be the answer.

We therefore recommend

1. That all undergraduate options in the major branches of engineering be omitted—to be specific, such options in civil engineering as aeronautical, highway, municipal, railroad and sanitary engineering. We recommend a single fundamental undergraduate B.S. course for all civil engineering students irrespective of their specialized interests or ambitions.

2. That subjects largely descriptive in character such as the details of highway construction, railroad operation and maintenance, the detailed design of water supply and sewage systems, the older type of courses in foundations, descriptive courses in materials, etc. be either entirely

eliminated from the undergraduate program or very radically curtailed.

3. That in the undergraduate program the division of time devoted to the four groups of studies above noted (*i.e.* a, b, c, and d) be substantially equal.

4. That, in the selection of suitable subjects in group (d), special attention be given to thorough grounding in those subjects—such as statically indeterminate analysis, basic work in the limitations of common theories and the principles of the theory of elasticity, soil mechanics, hydraulics and hydrology—which the student cannot secure without effective guidance. Furthermore, that those courses be selected as vehicles for instruction in the basic principles of civil engineering practice which best exemplify the interaction of the various factors of need and demand and the economics of design, construction, and operation, and for which qualified staff of broad interests and experience is available. In other words, we do not feel that any rigid selection in this latter area is desirable but that, on the contrary, it should reflect the special interests and staff abilities of the individual school.

Finally we urge that every possible effort be made to secure the successful and effective development of the four groups of subjects comprising the undergraduate curriculum into a well-coordinated and integrated whole. These are not four independent and unrelated groups of study. The divisions which exist are solely for the purpose of providing an organized sequence of studies and distributing teaching duties. Without full cooperation and integration such an engineering course becomes a hodge-podge of unrelated disciplines and its true educational value is completely lost.

While parts of the reports refer particularly to civil engineering, the basic ideas apply equally well to chemical, electrical, mechanical, metalurgical, and mining engineering and other branches.

One subcommittee member takes exception to the section on options. A member of another committee comments as follows:

"... one of the problems that seems to me in line for discussion in mineral engineering curricula is the need for appreciation on the part of students that it is not sufficient for them to have nurtured *ideas* while in college and to have learned to deal with *things*. Much of their progress in a professional way will depend not on their having ideas nor on their knowledge of material systems, but upon their ability to work for *people*, with people, and to get people to work for them. This kind of knowledge requires a perception of the well-springs of human nature, a perception that youth is not likely to develop.

Courses designed to increase knowledge in this field are bound to be very difficult to teach effectively. On the other hand, it seems to me that it should be possible to make college students realize that this is the most important activity that they will have to enter into professionally or otherwise in their adult life, and that they must be prepared to continue to go to school after they graduate with this topic of human understanding and human relations as a cardinal objective of their professional development. Certainly, people are not placed in managerial positions unless they are able to keep harmony in human relations. At least when a man is selected for the assignment, he is selected on the grounds that he appears to be the best to accomplish this happy result, and at the same time has an adequate knowledge of the things and ideas involved to carry the enterprise forward effectively."

However, with this one exception, all members of the committee of 23 endorse and approve the report.

At the suggestion of President Freund, the following questionnaire was submitted to 138 institutions, either to the Dean of Engineering or Director, as the case might be. To date, 93 replies have been received:

"Would you care to answer a very simple questionnaire? To what extent has the design of the various curricula in engineering in your institution been affected by the following reports of either S.P.E.E. or A.S.E.E.? In each case simply note significant changes, if any.

1. "The Investigation of Engineering Education."
2. "Aims and Scope of Engineering Curricula."
3. "Engineering Education After the War."
4. Note other reports of the society which have influenced decisions, and in what way.
5. Are your procedures at variance with committee reports of the society? If so, in what significant respects?

To summarize the situation, it may be stated that there is no shadow of doubt but that the articles mentioned have had profound and deep effect on the vast majority of the institutions regarding the setup of the various curricula in engineering. However, it is also true that a few institutions claim that they have not been influenced by these reports and have originated their own plans. However, no Dean or Director has stated categorically that their procedures are at variance with these various reports, except that quite a number of institutions have gone on the five-year plan, following the trend of emphasis on fundamentals, and placing highly specialized work in a graduate program or a fifth year; and also, making room for desirable humanistic and social studies. The replies from the various institutions are on file in the Office of the Chairman, and would be available on a loan basis if desired and if approved by President Freund.

The Committee consists of the following:

D. L. Arm	J. H. Lampe
J. K. Finch	R. F. Mehl
A. M. Gaudin	E. M. Schoenborn
E. Hutchisson	R. L. Sweigert
W. N. Jones	P. Cloke, *Chairman*

In the News

A "Directory of Secondary Schools in the United States," just issued by the **Federal Security Agency**, lists public and private schools in every state, the District of Columbia, and the Territories, and furnishes information on each school's accreditation status, number of students and graduates, number of teachers, and other facts. The directory, prepared by the Office of Education, is the most comprehensive guide to information about high schools in the United States ever issued. It lists by name more than 27,000 secondary schools of all organization types, including junior high schools.

Copies are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., as Office of Education Circular No. 250. The price of a single copy (496 pages) is $1.50.

A gift of $1,000,000 from Alfred P. Sloan, Jr., Chairman of the Board of the General Motors Corporation, has been received by the **Massachusetts Institute of Technology** for construction of a Metal Processing Laboratory building.

The gift is part of the total of $5,100,000 received by the Institute during the last year, according to Dr. James R. Killian, Jr., President of M.I.T. The total includes numerous grants-in-aid from industrial companies, all of which expect indirect returns through the strengthening and broadening of the Institute's program of research and education.

The **California Institute of Technology's** new $407,000 Earhart Plant Research Laboratory, science's nearest approach to a "weather factory" in which all types of climatic conditions can be man-made for study of their effects on plant growth, will be dedicated on June 7, it was announced today.

Progress Report on ECPD Activities

At a meeting of the Executive Committee of the Engineers' Council for Professional Development on May 23, 1949, H. T. Heald, President of Illinois Institute of Technology and Chairman of the Committee on Engineering Schools of the ECPD, announced that 106 engineering colleges have been visited by inspection committees during the past two years. A total of 481 curricula have been inspected, including 112 new curricular inspections. It is anticipated that by the end of the inspection year a large share of the previously accredited curricula will have been reviewed and virtually all new curricula for which inspection has been requested will have been examined.

The Committee on Engineering Schools is also studying the accreditation of graduate work in engineering. It is also attempting to develop better procedures for handling specialized engineering curricula.

The Committee on Professional Training, headed by A. C. Monteith, vice-president of Westinghouse Electric Corporation, is embarking upon a seven-point program, focusing attention upon improving the professional training in the post-graduation years. This program includes:

(a) a comprehensive survey of post-graduate programs in engineering colleges, industry, the government, and engineering societies;

(b) a study of methods of developing community-level programs aimed at improving the professional status and training of the engineer;

(c) an analysis of the professional registration of engineers;

(d) the encouragement of personal appraisal of the engineer in relation to his job, his community, and the engineering profession;

(e) a study of orientation and training programs in industry, with a view toward disseminating information along this line which will aid both large and small companies in developing suitable programs;

(f) the revision of selected bibliographies of engineering subjects; and

(g) the preparation of a selected reading list for young engineers. The latter two projects are nearing completion.

The Committee on Professional Recognition of the ECPD, headed by Ole Singstad, has prepared a report on uniform grades of membership in engineering societies and minimum qualifications for each grade of membership.

The membership grades recommended by the Committee include:

(1) member
(2) associate member
(3) student member

In addition, it was recommended that the optional grades of "fellow" and "affiliate" be included.

The recommendations of the Committee have not been finally approved by the ECPD, but will be considered at its Executive Committee meeting on July 28. If approved and adopted by the participating societies, this action will serve to unify the grades of membership in the various engineering societies so as to avoid the confusion which exists at the present time resulting from non-uniformity in membership grades.

The next Annual Meeting of the ECPD will be held at the Edgewater Beach Hotel in Chicago on October 28 and 29, 1949.

THE T-SQUARE PAGE

Devoted to the Interests of Engineering Drawing

W. J. Luzadder, *Editor*
Purdue University

We take the liberty of publishing a letter recently received from the Dean of one of our Colleges of Engineering. The letter was written in reply to our request for a statement along the line of some remarks he had made at an informal meeting last winter.

''Dear Professor Luzadder:

It is with a very real feeling of diffidence that I reply to your request for a contribution to the pages of the ''T-Square'' because I am not a teacher of engineering drawing and cannot claim competence in any branch of the subject. Maybe that fact alone will qualify me to write in answer to your kind invitation, certainly I can *not* be accused of bias!

I think that engineering drawing is one of the most important subjects of the curriculum in the education of the engineer, for several good reasons. Among them are:

a. It is an indispensable tool of the engineer throughout his life, even if he never practices engineering. How many times has one been delighted with an accurate, easily understood sketch of a wholly non-engineering subject and quite removed from all technical atmosphere? It can be made to supplant many lines of written description—may even be read and understood by one with no medium of spoken words.

b. It is incomprehensible how one can gain any knowledge of science and engineering without the use of proper diagrams, drawings, sketches, etc., to say nothing of mapping. We can imagine commerce getting along without shorthand, but not engineering work without drawing!

c. Coming early in the various curricula, drawing serves to bring the new student close to a realization of his objective in trying to fit himself for his career. Possibly many teachers of engineering drawing do not realize the special opportunity they have in beginning to nurture this idea of ''career'' in the beginning student. Particularly is this true if the teacher can draw from his own experience as an engineer and point up his dicta by apt references to the usefulness of the work as it unfolds.

d. One of the most helpful attributes of a properly taught course in engineering drawing is that of discipline. If I may be pardoned a personal reference, engineering drawing was one of the most difficult subjects I had in my college work; not because I did not understand it (with reasonable diligence, even descriptive geometry made good sense to me) but it was the necessity of being neat and accurate! My own clumsiness was more difficult than the ideas of ''upness and downness, frontness and backness, rightness and leftness.'' But I was *compelled* (and I mean with a capital C) to learn to start and stop at the right place! Since we must all agree that discipline is a watchword in the education of the engineer, I don't know of a better place to include it than in the drawing room.

And finally, may I say let us never unwisely economize with the talent we have in our Drawing Departments. There may be places where the idea prevails that the highest quality of personnel is not necessary for the Drawing Department, but thank goodness that place is not this College!''

New Members

Ajax, Fred W., Associate Dean of Students, Georgia Institute of Technology, Atlanta, Georgia. R. L. Sweigert, R. S. Howell.

Albrecht, Carl F., Assistant Professor of Agricultural Engineering, Michigan State College, East Lansing, Mich. H. P. Skamser, H. L. Aldrich.

Allman, James M., Assistant Professor of Mechanical Engineering, University of Delaware, Wilmington 11, Del. D. L. Arm, F. Zozzora.

Arnold, Isaac, Vice President, Quintana Petroleum Corporation, Houston, Texas. C. J. Freund, A. B. Bronwell.

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Brush, Edward E., Head, Aeronautical Engineering Department, Texas A. & M. College, College Station, Texas. R. P. Ward, J. D. Lindsay.

Burchard, John E., Dean of Humanities, Massachusetts Institute of Technology, Cambridge 39, Mass. T. K. Sherwood, L. L. Moreland, E. S. Burdell, R. S. Bowman.

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Cossa, John A., Associate Professor, Education, General Guidance Director, Manhattan College, New York 63, N. Y. Brother Aubert, Brother A. Leo.

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WORK, HAROLD K., Director of Research Division, College of Engineering, New York University, New York 53, N. Y. T. Saville, F. K. Teichmann.

112 applicants this list

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L. C. Frank

L C Frank
Chief Engineer
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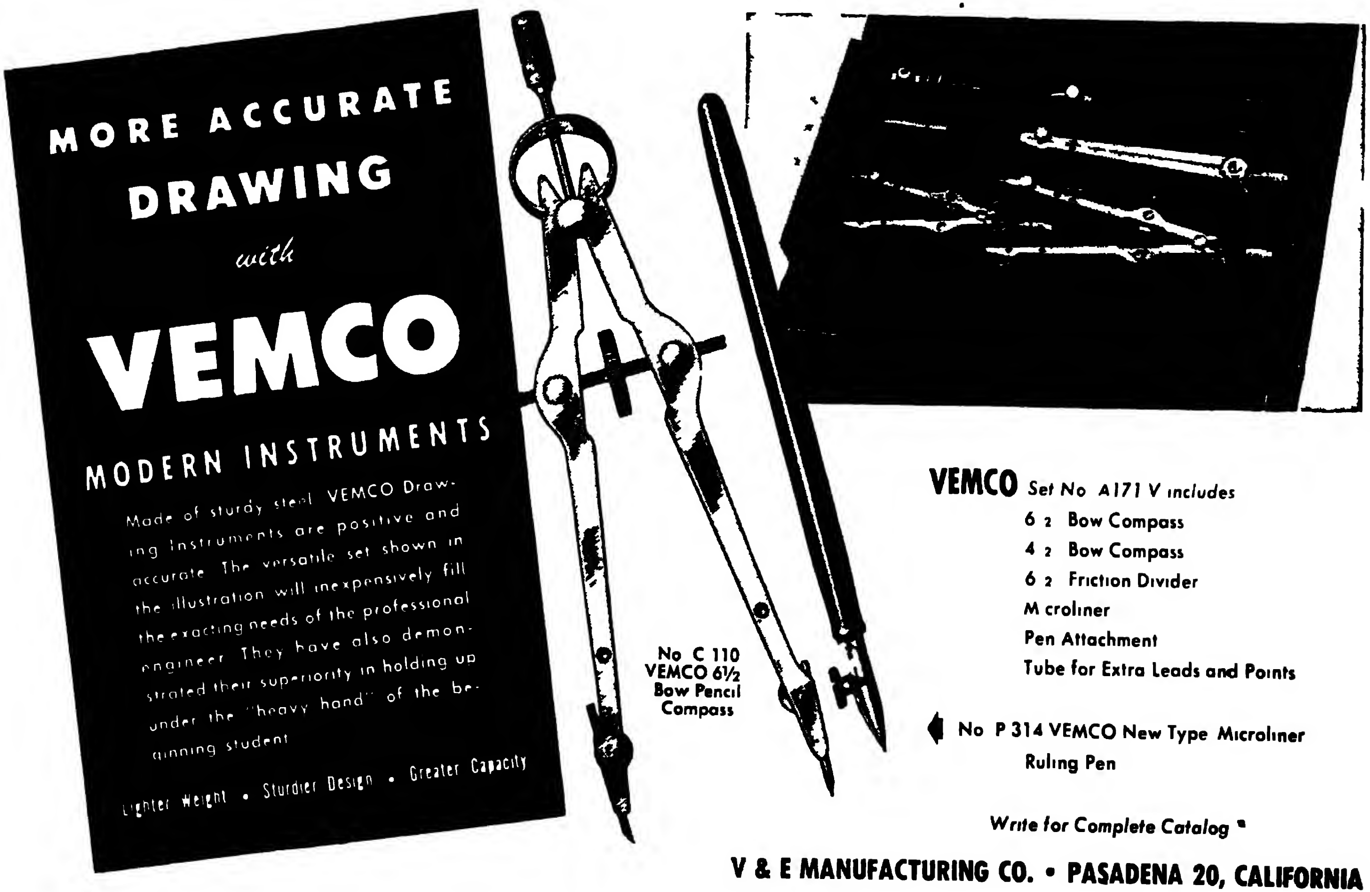

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Toiling in the Night

By B. J. ROBERTSON

Vice President of the ASEE and Professor of Mechanical Engineering, University of Minnesota

If one of us were asked the question "Who speaks for your schools?", he would undoubtedly reply "Why the President is the only person who has such authority." But many visitors have talked to no one except building custodians, whom they ask for directions, or a clerk in some office, or a student. So far as these visitors are concerned the courtesy, interest, or friendliness expressed by any one of these people reflects the character of the institution. A snippy clerk, a grouchy janitor, a smart-aleck student, may be responsible for the impression made upon the visitor and it is they, unfortunately, who then speak for the school.

Since the ASEE has no physical plant, no janitors, no students, all of the personal contacts for the Society are made by its individual members. The president, the vice presidents, the secretary and his office staff contact relatively few of the large number of people who have interests in common with the Society.

Those who participate in meeting programs, local, regional, or at the annual meeting, contact more people. But with the all-high record of attendance at the annual meeting at Rensselaer Polytechnic Institute, only about 20% of the total membership attended and each individual heard a relatively small number of the papers given. Members leaving ASEE gatherings have been heard to remark, "That was really an interesting talk" or "There were really some good ideas in that paper but it was poorly organized" or "A good subject but a poor speaker" or "I personally like more facts and less opinions," etc., etc. Impressions of the speakers are often translated into opinions of the Society, and have much to do with its future. Those whose papers are selected for publication in the JOURNAL speak to much larger audiences and assume correspondingly greater responsibility.

Many excellent papers are selected for publication from those presented at meetings of the various divisions in connection with the annual meetings of the Society or papers presented at section or branch meetings. The divisions have been set up to draw together those with common interests, to enable them to discuss common problems, or to carry on important projects in their particular field of education. A member may well be interested in more than one of them. He is welcome to take part in as many of them as his interest dictates. Division, section and branch officers are constantly looking for speakers who can make worthwhile contributions to progress in engineering education. These speeches or papers are no less important than those presented before technical societies which are often the results of months or years of study and investigation.

The ASEE is the only society devoted exclusively to engineering teachers. It is our professional society. It does not concern itself with purely technical problems. To do so would be to infringe upon the functions of technical engineering societies. Many leaders in engineering are protesting against the multiplicity

of such organizations and find therein an obstacle to the effective organization of the engineering profession. We are indeed fortunate to have only one organization devoted to engineering education.

The ASEE owes its present position, its national and international prestige, its influence in the entire field of education to its prominent engineering educators, its competent committees and its active divisions, sections and branches. Through these agencies, individuals and groups of individuals have reported the results of years of study and research. They have exerted a profound influence upon the development of engineering education in these United States.

The future depends upon those who who will take it upon themselves to carry on the work so well done in the past.

"The heights by great men reached and kept
Were not attained by sudden flight,
But they, while their companions slept,
Were toiling upward in the night"

Many of us may not be able to reach the heights attained by past outstanding writers in the Society, but wise planning, early beginnings and constant effort may carry us further than we think.

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Where Do We Stand on Point Four?[1]

By the Honorable GEORGE V. ALLEN
Assistant Secretary of State for Public Affairs

President Truman, you will recall, launched the planning of a world technical cooperation program, on a cooperative basis, with his declaration of policy at his Inauguration last January 20.

He said that the United States, in cooperation with the UN, and with other governments, would attempt to pool the technical knowledge and skills of the more advanced countries to stimulate the progress of the underdeveloped countries.

There was obviously both selfishness and altruism in Mr. Truman's proposal. It was selfish because the United States does its greatest trade with the countries that are economically prosperous. It was selfish because an economy of private enterprise can remain most healthy in a world-wide expanding economy. It was selfish because the peace of the world and the security of the United States depends upon the well-being of the underdeveloped nations.

On the other hand, this plan was altruistic because the United States was not seeking any political favors. It was asking no privileges for American business greater than those accorded to businessmen from any other country. And the United States was willing to contribute more than its proportionate share in this program.

The President called his plan "bold and new." It is bold because for the first time a major nation has made it a national concern to facilitate the development of lesser developed countries, which contain well over half the population of the world, and because the plan looks beyond the immediate political alarms and crises to a long-range program, extending over many decades. This proposal is a demonstration of confidence in the possibility of achieving world peace.

The program is new in its world-wide scope. On a small scale, our government has had experience with this type of program in Latin America.

Now what has been happening on the plans for Point Four since last January 20?

The United Nations Organization has given active leadership. The Secretariats of the United Nations Specialized Agencies have had numerous meetings to discuss the work which their organizations might undertake in the fields of agriculture, education, health and general economic development. The Secretariats have now submitted their proposals to their various governing bodies. You may have seen a news story recently from New York, indicating that the total of these proposals would cost 84 million dollars for the first two years. Next month at Geneva, Switzerland, the Economic and Social Council will review these proposals. Thereafter the combined United Nations program will be examined by the United States and other members of the United Nations who are willing to contribute to the Point Four program. As you know, the Point Four program is a wholly voluntary con-

[1] Banquet address at the 57th Annual Meeting of the A.S.E.E., Troy, N. Y., June 23, 1949.

tribution, over and above our membership assessment in the United Nations.

Within the United States Government itself the Department of State has been given responsibility for drafting the necessary legislation and recommending a first year program. This work is now completed and the President will probably be sending to Congress this week a message requesting consideration of Point Four legislation at this Session.

It is not possible to discuss the contents of the first year's program, because each project will have to be negotiated with another government, and part of the expense will be borne by the other government.

However, I can assure you that engineering will play a prominent part in that program, and subject to approval by the United States Congress, and by other countries which may contribute to this cooperative venture, hundreds of American and other engineers will be going annually to assist the governments of underdeveloped areas of the world.

I do not mean to over-emphasize the role of government in this program, for it is likely that United States engineering firms and contractors will contribute a major share to the Point Four program.

Programs Now Under Way

I am unable to give you details of the proposed program, but let me review some of our recent experiences in working with other governments on engineering matters.

The government now has two programs of technical assistance in Latin America.

First, there is an Interdepartmental Committee on Scientific and Cultural Cooperation, which draws upon the technical skills and personnel of all the federal agencies to supply technical assistance to other governments. I am Chairman of that Committee, which has about 180 technicians working in Latin America today.

Second, there is a government corporation, the Institute of Inter-American Affairs, which is conducting programs for the improvement of the basic economy of Latin America. It works primarily in the fields of food supply, health and education. I sit on the Board of Directors of that corporation.

These two programs utilize engineering skills of many sorts in assisting other governments. Here are some examples:

1. *Mining.* If you go to Mexico City today, you will find in the laboratories of the Mexican Government two mining engineers supplied by the United States Bureau of Mines. These are shirt-sleeves men who are helping the Mexicans work out processes for extracting or reducing ores, so as to make mining less expensive. The United States supplied these men primarily because of our interest in lead, zinc, and other strategic minerals. However, they are available to work on any mining or metallurgical processes requested by the Mexican Government.

Since 1942, the United States has sent to Brazil a number of geologists to assist that government in locating and mapping its strategic minerals. These American geologists and their Brazilian colleagues have uncovered the largest deposits of manganese in the Western Hemisphere. The United States, since its earliest development of iron and steel, has been forced to import manganese from the other side of the Atlantic and the Pacific. Now, for the first time, we may become self-sufficient within this hemisphere. United States Steel has entered into a contract with the Brazilian Government for development of one of these manganese deposits.

2. *Irrigation.* In Haiti, an engineering field party of the Institute of Inter-American Affairs has just completed a small concrete aqueduct carrying water out of the mountains into the arid coastal plain about twenty-five miles behind the capital of Port-au-Prince. This aqueduct is irrigating approximately 1500 acres of land that have been largely abandoned since French colonial days over a hundred years ago, and the irri-

gated area is now being expanded. Haiti, as you may know, has a severe food shortage.

3. *Drainage for Malaria Control.* Engineers of the Institute of Inter-American Affairs were asked to tackle the malaria problem in the Santa River Valley in Peru where twenty-five per cent of the population were infected. The mosquitoes were breeding in marshes along the river. In one year the Institute engineers drained the area surrounding the mouth of the river, and the incidence of malaria dropped from twenty-five per cent to two per cent. The cost of this project was supplied largely by the Peruvian Government, and the labor was Peruvian. The United States supplied the technical knowledge.

4. *Aviation.* The Civil Aeronautics Administration has field parties in five Latin American countries today, advising other governments on the location and construction of their airfields, and the maintenance of their airways communications. Many of the United States personnel are engineers.

5. *Brazilian Air Mission.* In Brazil the United States has facilitated an entirely different kind of aviation mission. The Brazilian Government itself has recruited twenty of the outstanding aviation technicians of the United States, employed directly by the Brazilian Government to develop a national aviation program. The staff is headed by Dr. C. I. Stanton, former deputy administrator of the U. S. Civil Aeronautics Administration, and Professor Richard H. Smith, former dean of Aeronautical Engineering at M. I. T. These men have organized a complete engineering school for the Brazilian Government.

6. *Mechanical Engineers.* The Department of Agriculture has sent to Cuba several mechanical engineers who are helping to develop the necessary machinery for extracting fiber from the kenaf plant. Kenaf is an agricultural product developed by United States and Cuban scientists to replace jute. The agricultural phase of the work has been completed, but the machinery for processing the fiber is not yet satisfactory. When this project is completed, the United States will no longer be dependent entirely on the Far East for this important type of fiber.

7. *Water Supply Engineers in the Amazon.* The Institute of Inter-American Affairs engineers have supervised the construction of about twenty municipal water supply plants in Brazilian towns along the Amazon. The Amazon Valley was completely lacking in pure water systems, and water-borne parasites had become the principal national health problem. I recently heard an interesting anecdote about the first of these water systems in the Amazon, which was constructed in 1943. It was built in a town of 2500 people, which served as a county capital. The engineers, in order to allow for population expansion, built the system to supply 4000 people. Within two years after the water system was constructed, people had moved from miles around into this town, and its population had grown to 6000 people—fifty per cent greater than the water supply capacity. The plant had since been enlarged. Moreover, this town had been located for centuries on the bank of the Amazon, because everyone had to carry water in buckets from the river bank. Within one year after the water system was constructed, the population began moving inland from the river and the center of town now is almost two miles from the river, on higher and more healthful ground. That is what one American engineer can contribute to one foreign community.

8. *Training Engineers in the United States.* Many of our federal agencies are conducting classes and individual training courses for technicians from Latin America. More than 2000 technicians and scientists have been brought to the United States under this program during the past ten years. Approximately 400 of these were in various fields of engineering. Right now in Washington there are training courses going on

for Latin American engineers in the Public Roads Administration, the Civil Aeronautics Administration, the Bureau of Reclamation, the National Bureau of Standards, the Coast and Geodetic Survey, and the Public Health Service. This last agency is training sanitary engineers.

9. *London Science Staff*. An entirely different kind of engineering activity is represented by the Science Staff in the United States Embassy at London.

The Department of State has maintained a Science Staff in the London Embassy for almost two years. This staff both acquires and gives information on a scientific and technical nature.

Engineering Participation

Last year, from April 1948 to April 1949, an engineer was the Chief Scientific Officer—Dean W. R. Woolrich, Dean of the College of Engineering, University of Texas. His contribution to the work of the Staff was considerable, and is illustrative of the kind of assistance engineers will be giving to the Point Four program, as well as other U. S. foreign programs. He made a study of government sponsored research in the Department of Scientific and Industrial Research in Great Britain. He surveyed and appraised the whole system of engineering education, government and private, talking with officials in engineering schools and assessing the kinds of courses, methods of teaching, requirements for degrees, selection of students, and organization and management of engineering colleges. While in London, Dean Woolrich was a member of the U. S. Educational Commission in the UK administering the Fulbright program in Great Britain.

Dean Woolrich also worked on a plan to promote Western European interchange of unclassified industrial and agricultural technology now in possession of the governments participating in ERP. He cooperated with ECA and OEEC and with British and French government officials in developing the plan which has been accepted by the OEEC. Arrangements are now underway to put the plan into effect. Exchange arrangements are to be carried out by the countries among themselves. If successful, the project is likely to aid significantly in European economic recovery, and to place the cooperating countries in a much stronger position to participate in the Point Four program than they otherwise would be.

The best example I can recall of how the government and private enterprise work together in this field of technical cooperation is a story that came out of Afghanistan. In 1935, the Afghanistan Government sent to the United States a student of engineering. After he had graduated from an American engineering school, the Bureau of Reclamation took him into its laboratories at Denver for nine months of training. Shortly after this student returned to Afghanistan, he was appointed Minister of Public Works. When consideration arose in 1942 for the construction of a major dam in Afghanistan, this former student asked the United States Government if it could send a survey engineer. The State Department arranged for a trip by Mr. Jack Savage of the Bureau of Reclamation, whom many of you know as the designer of Boulder Dam. Jack Savage spent only a month in Afghanistan, advising on the feasibility of the project. The Afghanistan Government then issued a series of contracts to United States engineering and construction firms, now aggregating many millions of dollars.

Here in one sequence you can see the relationship of our program for foreign students, our training of foreign technicians in the United States Government agencies, our sending of technical advisers to other governments, and the role played by private American companies.

As soon as these professional schools are established, it is found that the scientific training and particularly the laboratory work in the high schools is inadequate, and it is necessary to revise the high school curriculum.

In many underdeveloped countries we find that education has been restricted to the wealthy families who have a social repugnance for hand labor. They lack what Harold Lasswell calls "the dignity of overalls."

International Exchange of Students

One of the methods which the United States has attempted to use in overcoming this attitude is to recommend handicrafts and shop work in the primary schools of a country. We have tried to break down the social attitude towards manual labor at the youngest possible age.

These educational problems are fundamental in any improvement to engineering services in most backward countries.

This year the United States has had over 25,000 foreign students enrolled in its universities. Approximately 5100 of these students were studying engineering. That is over twenty per cent. Nearly all of these students have been assisted at one time or another by our cultural officers in the American missions abroad, or by our reception centers in the United States for assisting foreign visitors. The State Department is doing its best, within the limits of our university capacity, to stimulate both the quantity and quality of the foreign students. The most important contribution to this program, however, has been the excellent fellowship program and counciling services of the various universities, including our engineering schools.

I believe we have been more successful in aiding foreign students to come to the United States than we have been in supplying visiting professors to institutions abroad. Under the Point Four program there will undoubtedly be a greater demand than at present for the sending of United States visiting professors of engineering to other countries.

And this brings me to a subject of particular interest to members of your organization.

I believe that the Point Four program will put a strain upon the available pool of skilled personnel in this country, including the engineering profession. The government will be looking to its own staff, to private engineering companies and to universities to determine what outstanding engineers are available for foreign assignment, and those who can be spared will be the first assigned. But I foresee in the second and third and ensuing years a demand for personnel which will compel the United States to turn to its young college graduates to undertake assignments abroad. Many of our technicians in Latin America today are under thirty years of age. I believe this is true of a majority of our sanitary engineers.

This is a problem which should be of concern to all of our professional schools. It means that some of our engineering students, to be properly prepared for their work, should have foreign languages and some "area studies." It means that the counseling services of our universities must become more familiar with the overseas opportunities for college graduates.

Such foreign assignments will be an all-around benefit to the United States and to the individual. The individual will be given experience far beyond his years, and beyond any opportunities he would have in the United States to exercise such broad authority at so young a period in his life. This in turn enriches the pool of trained man-power which the United States possesses, and gives our nation a richer experience in world affairs, which will enable us better to fill our new role in world leadership.

I have heard it said that engineers contributed more to the winning of the war than any other profession.

I foresee that the role of engineers in the program for peace, as laid down by President Truman, will be equally important.

Planned Individualism in Engineering Education*

By LIVINGSTON W. HOUSTON

President of Rensselaer Polytechnic Institute

On behalf of the faculty, my colleagues in the administration and the members of the Board of Trustees, as well as personally, I am happy to welcome you to Rensselaer Polytechnic Institute. I hope that your visit will be both pleasant and profitable.

Under any circumstances the annual meeting of the American Society for Engineering Education is a significant event. In the environment in which this gathering is being held it is especially significant. Today we meet not only to review the achievements of the year but also to commemorate a century and a quarter of continued progress in engineering education. In 1824 this institution opened its doors on the banks of the Hudson not far from the building in which we are gathered this morning. Those of you who represent the colleges of engineering throughout the United States and Canada will therefore find this pilgrimage of more than ordinary interest. Those of you who represent the industries of America will, I trust, find it no less interesting.

I am particularly happy that the American Society for Engineering Education has chosen to hold its annual meeting this year in Troy and to join with us in the celebration of 125 years of uninterrupted service. Although we at Rensselaer Polytechnic Institute take a modest pride in its history, engineering education has always been a cooperative undertaking; and your own institutions share with us the traditions which we cherish.

We are, therefore, proud that one of our graduates, DeVolson Wood, of the Class of 1857, was the first president of our first cooperative organization, the Society for the Promotion of Engineering Education, parent organization of the A.S.E.E. We are likewise proud that another man of Rensselaer, Benjamin Franklin Greene, was the first in America to analyze the problems of engineering education and to foster a forward looking program on the basis of his analysis. To quote the Wickenden report, Greene developed "an educational discipline complete in itself, not narrowly utilitarian but adapted to the complete realization of true educational culture."

Greene was a practical man. He went to Europe first and studied the systems of engineering education there. Then on the basis of what he had observed, he developed his own program here, a program which has given American engineering education its distinctive form and character. In its essentials this program is still sound today. Since Greene's day all colleges of engineering have contributed in some way to the development of engineering education. The American Society for Engineering Education stands, therefore, as a symbol of a great cooperative venture in which we are all pioneers.

Planned Coordination

In the constitution of our society one of the purposes is stated as "the coordination of institutional aims and programs both among the schools and colleges and in their joint relations with professional, educational and public

* Presented at the General Session of the A.S.E.E. Annual Meeting, Troy, N. Y., June 21, 1949.

bodies." To me the important words here are "coordination" and "joint." They suggest one of the things on which we must concentrate in the years ahead under the guidance of the A.S.E.E. even more than we do now. We have reached a point where such joint planning becomes essential. This is particularly true of our graduate and research programs. Our job has been vastly complicated by the many new developments in science and engineering. There is a great deal to be done and there are enough of us to do it, but I submit that we are going to have a steadily increasing degree of coordination between our programs if we are to function at peak efficiency. I do not mean to imply a program of planned economy.

Perhaps I can give this idea better focus if I give it a name. Let's call it "planned individualism"—among our schools; or if you like, cooperative competition.

We all enjoy competition. It is one of the bases of our American culture. You might almost say it is native to our soil. The results of it are what still set us apart from other nations. It has made us great, wealthy and powerful in industrial might. It has brought us to world leadership. It has given us tremendous responsibilities. But the blade of competition can cut two ways. One recalls the phrase, "cut throat" competition. That's out of favor now, but when our fathers were growing up, young America, bursting at the seams, looked with awe and with some admiration at men whose business practices would not pass muster today.

So we have learned that certain kinds of competition can get us into trouble. Today we watch our competitive practices, and when they prove unfair, we rule them out.

We have learned that in times of national crisis competition would work against the best interests of our country, and then we have turned to such forms of planning as price control, for example, and the pooling of our industrial know-how.

Competition Among Educational Institutions

American educational institutions delight in competition. We compete for students, for faculty, for money, for public favor, for industrial grants, for the support of philanthropic foundations, and we compete on the playing fields. We are competing for fame, and sometimes the type of fame has a tendency toward the superficial. It comes to mean anything that has a superlative "st" on the end of it.

For example, School "X" allows the world to find out that it has the biggest cyclotron; School "Y," that it has the longest wind tunnel, another one has the best towing tank, another the most powerful telescope, another the largest enrollment, another the biggest graduate school, another the prettiest co-ed, and I should certainly add here, still another the best lacrosse team.

We hire specialists in public relations to make sure that our alumni and the rest of the world know how many "st's" we can claim.

All these things I have been mentioning are part of our competitive system. Most of it is healthy, but some of it can be harmful. Part of it is superficial, and that doesn't matter very much, but some of it is basic, and that does matter.

Now I would like to recall what I suggested a few moments ago—what I called "planned individualism," or, if you prefer, cooperative competition. With a deep bow in all directions I would like to submit that no one of us is really *the* engineering school of America and in so far as we consciously try to earn the reputation of being that school, we run the danger of spreading ourselves too thin. There is manifestly far more for us to do than any one of us can accomplish alone. No one engineering school can be all things to all men. There can never be such an engineering school. Every school has some significant con-

tribution to make. The more we learn in our respective fields of concentration the more apparent this becomes. Attempts to satisfy all our potential customers, to meet the demands of every type of graduate student who comes to our doors will leave us in the somewhat unstable position of Stephen Leacock's hero, Guido the Gimlet of Ghent. As you recall, at one point Guido "leaped on his horse and rode off in all directions at once."

It is a commonplace to say that science and engineering become more and more a matter of team work. Within our respective graduate schools at this moment we each undoubtedly have teams made up, for instance, of an electrical engineer, a metallurgist, a biochemist, and an aeronautical engineer, working on a common problem which none of them could solve alone. Would it not be possible to develop an even greater measure of team work between the schools themselves. Steps toward this end have been made through the A.S.E.E. I am raising the question of whether it is not time to coordinate our program even further--in cooperative competition.

Obviously, what I am recommending applies mostly to graduate schools and research programs. It is in them that we run the danger of needlessly duplicating each other's efforts, of wasting time and money and personnel.

Please don't get the idea that I am advocating regimentation of curricula to the point where each school is arbitrarily allotted its particular fields of concentration. Such a concept is abhorrent to us all. I am simply suggesting that we could work out a voluntary program of planned individualism—and I stress the work "voluntary"—which could insure that we use our facilities, and our faculties and our funds to best advantage.

Industry-College Cooperation

I believe a further measure of cooperation is possible among us, particularly as it pertains to the support that American education must have from American industry. Some progress has already been made under the auspices of the A.S.E.E., as well as by individual colleges. I believe that more is possible and vital. I believe that American industry, if once properly educated, will come to recognize the extent of its responsibility to our scientific and engineering colleges, and will then act favorably on that recognition. It has not done so to date. That it hasn't is *our* fault. We have taken our story as individuals to individual companies. The job ahead of us is the education of all industry. This education of industry should be accomplished by a joint effort on our part and not piecemeal by each of us as individuals as we seek our special subsidies for our own projects. I believe that industry will welcome a comprehensive presentation of the matter which reflects the problems common to us all. I believe that we could then work out with industry a voluntary plan under which we would have a more equable and particularly a more efficient use of industry's support, and I believe that as a result of this cooperation the support would be vastly greater.

You have been given a little brochure with a red border at the top called "American Industry and the Colleges of Engineering." This is a survey made by Rensselaer, and the fact that each of you has a copy should indicate that it was made for the benefit of all. I have no doubt others of you may have made the same sort of survey in the past—or were perhaps contemplating something like it for the future. I hope it will benefit you as we hope it will benefit us. In any event, here it is for such use as we care to make of it. It doesn't give all the answers and it can't promise 100% accuracy. No questionnaire can fail to reflect the type of answer sought, as many of our eminent pollsters were quite ready to admit on the morning of last November 3rd.

Be that as it may, this industrial survey is very encouraging to me. The questionnaire was sent to the presidents of our great industrial firms and for the

most part it was the presidents who answered it, usually in their own handwriting. In replying to one of the questions, two-thirds of the more than 550 respondents stated that they believed business and industry should help the schools of science and engineering to a greater extent than they do now.

I construe this as a downright invitation. I believe it is a project which fits admirably into the program of our society. If we can educate American industry as well as we educate the engineers who are its life-blood, neither we nor industry need have any fears for the future. A whole industry has frequently banded together to tell its story to the general public. Usually when it has acted together in this manner, the results sought for were achieved.

With the ever mounting cost of laboratory equipment and with the growing complexity of our research programs, engineering education needs a solid block of financial support. Many of us believe that if this support were forthcoming from the National Government, serious restrictions on our institutional freedom would result. I believe that we can obtain that solid financial support which we need without large amounts of government aid and a continuing drain on the Federal Treasury.

Legislative Requirements

Congress should be persuaded to liberalize our tax procedure because many people with medium to large incomes just cannot afford to continue the generous support of education practiced a few years ago. Let us cooperate to help bring back this private form of educational support.

We must further, as a group, tell industry of our situation, our aims and our needs. And then we as individuals must seek out those industries which we can serve and which can best take advantage of working with us.

I congratulate this Society for the choice of the theme of this meeting – Partnership with Industry. I am certain that through the full realization of that theme we can achieve an educational program which will usher in an age of Health and Abundance for all peoples.

We are indeed honored that you are here to help commemorate the 125th anniversary of the founding of Rensselaer Polytechnic Institute.

Again, may I tell you how glad we are to have you with us at this time. This is your convention—we want it to be both pleasant and profitable—and we will try our very best to make it so.

E.C.R.C. Review of Current Research Available

A compilation of the titles of all currently-active research projects in engineering at the 82 institutions which are members of the Engineering College Research Council has been announced by the Council. The volume, published under the title ***Review of Current Research and Directory of Member Institutions***, contains nearly 200 pages of data on research projects and policies. More than 4000 project titles are listed, and all are covered in an index of research project subjects.

Copies of the *Review*, which is compiled biennially by the Council, have been supplied to the libraries of all institutions which hold membership in the Engineering College Research Council. Members of the Society may obtain personal copies for $1.25 each, approximately cost; the book is regularly available to non-members for $1.75. Orders should be addressed to Mr. John P. Weber, Assistant Secretary of the Research Council, at the College of Engineering, State University of Iowa, Iowa City, Iowa.

The Financial Dilemma Facing the Colleges*

By FRANK C. HOCKEMA
Vice President and Executive Dean, Purdue University

Equality of educational opportunity has always been one of the fundamental ideals of American democracy. Starting with the constitution of the United States of America and the Bill of Rights as a foundation, there has been steady progress toward making this ideal a reality. During the past half century the enrollment in colleges has increased tenfold from 250,000 in 1900 to 2,400,000 in 1949. This increase is evidence of our belief that education plays an important role in the progress of American democracy in war and in peace. The validity of this belief in the value of education is supported by the results of a survey made recently by Dr. Harold F. Clark of Columbia University, which shows that there is a close relationship between the economic and social well-being and the educational level of a people.

In the broad sense, education includes all experience, all learning, all growth, and all self-development. In itself it is neither good nor bad; it can lead an individual upward and forward, or downward and backward. The danger is not that we may have too much education, but that we may obtain the wrong kind. To provide the right kind and the right amount of education for each citizen is, therefore, vitally important. There is no saturation point in *wise* education. Education must lead the way if we believe in that old axiom, "What we want in the nation, we must first put in our schools."

Mr. J. Edgar Hoover, Director of the Federal Bureau of Investigation, estimates the cost of crime at seventeen billion dollars annually. (The human suffering caused by crime cannot, of course, be measured in dollars and cents.) Crimes are committed by those who have become anti-social and destructive as the result of the wrong kind of education received in the homes, the churches, the schools, and the workshops of the nation, and from the movies, the press, the radio and television. Would it not be wise to spend for the right kind of education at least a portion of the seventeen billion dollars which is now lost annually because of crime? How much, in terms of dollars and cents alone, would it be worth to the nation, the state, and the community, as well as to industry and business, if each individual were taught to be honest, reliable, ethical, loyal, well-balanced mentally, socially, spiritually, and physically, willing to work hard and enjoy it, well equipped for his work, and well trained as a self-sustaining and contributing member of a free and changing society?

Quality Education is Costly

We need more than "quantity" education; we need "quality" education as well. The survival and progress of our nation depend on the quality of the educational system. It is bound to take a large amount of money to finance quality education, but we should always remember that education is the best investment we

* Presented before the Committee on Relations with Industry at the Annual Meeting, Troy, N. Y., June 22, 1949.

Grateful acknowledgment is made to the members of the A.S.E.E. Committee on Relations with Industry and to approximately two hundred industrialists and businessmen for their helpful suggestions.

can make if we wish to offer a greater degree of equality of opportunity for the youth of each succeeding generation.

One of the important functions of modern education is to assist the people of the country to use wisely the resources and opportunities at their disposal. Throughout the years the objectives of quality education have become broader and broader. Little by little, step by step, the complexities of modern life have forced an ever-widening field of activity upon the schools. During the war and since the war, the institutions of higher learning have played an important part in the tremendous task of educating the youth of this nation for good citizenship, with all its implications. The financing of this ever-expanding educational program has been a problem of increasing consequence.

The beneficiaries of the right kind and the right amount of education are not only the individuals who receive it but also the nation, the state, the community, and every member of the community; and, specifically, every employer. The beneficiaries of quality education should be willing to assume their share of responsibility for its moral and financial support.

The unprecedented demand for higher education since the war finds most of the eighteen hundred colleges and universities in the United States understaffed, underhoused, underequipped and underfinanced. An estimated 2,400,000 students registered for the scholastic year 1948–1949 are accommodated in an educational plant designed to serve a maximum of approximately 1,600,000. The United States Office of Education estimates that attendance by 1950 will approach 3,000,000 students.

Post-war enrollments have been inflated, partly by the return of veterans who had deferred their schooling, and partly by the encouragement given to veterans under the G. I. Bill to attend college. While some temporary leveling off in enrollments is looked for in the immediate future, other forces than the G. I. Bill are expected to keep college attendance at a high level. Among these forces are scholarships, fellowships, and ever-growing interests in higher education.

Causes of Financial Dilemma

Permit me to list some of the reasons for the financial dilemma now facing the colleges and universities:

I. *Enrollments have increased approximately 100%*

The present enrollments are approximately twice those of pre-war years. Teaching staffs as well as the laboratory and physical plant facilities are inadequate to do justice to this great increase in students.

A. The colleges must increase their staffs

Because of shortage of funds and because of lack of trained teachers, it has not been possible to add enough staff members to give maximum service to the students. The teaching staff has been and is underpaid and overworked. It must be realized that teaching is largely an art and as such must be individualized by insistance on small classes and teaching loads sufficiently low to permit the teacher to know and understand his students.

B. They must increase their library and laboratory facilities

Libraries should be adequate to accommodate the increase in enrollment in both the undergraduate and graduate programs, and the increase in faculty.

Although laboratories and classrooms are used in many institutions from early in the morning until late at night, additional laboratory facilities are needed.

C. They must increase other physical plant facilities

II. *Current economic conditions have created urgent problems*
The devaluation of the dollar has affected salaries and the prices of labor and materials, thus adding to the financial problems.

A. The colleges should increase the salaries of staff members
The teachers have been loyal. This loyalty should be rewarded as soon as possible by reasonable increases in salaries and a decrease in teaching load. The need for increase in salaries is aggravated by two important factors:

1. Living costs and taxes have increased
The members of university staffs were already underpaid. Salaries must be raised to meet the increase in living costs and taxes.

2. Competition to obtain and keep competent staff members is keen
Colleges and universities, industries, and businesses are all competing.

B. Grants, gifts, and bequests have decreased in number and amount
As living costs and taxes increase, grants, gifts, and bequests, especially from individuals, have decreased in number and amount.

C. Income from endowment funds has decreased
The interest rate on securities reached an all-time low during the war years, and has increased but slightly since the war.

D. Increased cost of labor and material hampers both new construction and maintenance.
Present building costs are about three times those of pre-war costs for the same space. Because of the increase in the cost of labor and material, the need for additional new buildings can be met only by a large increase in funds for new construction.
In order to keep the physical plant in a good state of repair, constant work is necessary; and maintenance costs have increased at least 100%.

E. The costs of books, laboratory supplies, and other supplies have increased

III. *Post-war adjustment has created further problems*

A. Maintenance of physical plant had to be deferred during the war years
Because of the shortage of labor and materials, much of the maintenance of physical plant facilities was deferred. This accumulation of maintenance projects has now reached an all-time high.

B. New construction was postponed during the war
Because of the shortage of labor, materials, and funds, new construction during the war was reduced to a minimum.

IV. *Educational services must be expanded to meet the needs of the world today*

A. Research activities must increase
If research is all-important in time of war, it is equally important in time of peace. If this nation is to hold its place in the sun, the colleges must carry on more and more pure and applied research. Research laboratories, special

equipment, and research specialists are necessary.

B. The graduate program must be expanded

As our economy becomes more and more complex, we need increasing numbers of highly trained specialists educated and developed in the graduate schools. An adequate graduate program is costly.

C. An adequate counseling program is necessary

If education is to provide the right kind and the right amount of education for each individual, it is absolutely necessary to have an adequate counseling and vocational guidance program in higher education as well as in our secondary and even elementary schools.

D. Better public relations with business, industrial, and labor organizations must be maintained

In order that the education provided for the students may be practical as well as theoretical, the colleges and universities will have to spend more money in keeping the members of the teaching staff in close touch with off-campus organizations. This involves funds for staff travel and frequent leaves on pay for visits to other institutions, advanced study, and work in industry and business. Staff members should be encouraged to work in industrial and/or business organizations for a semester or two every three or four years.

Sources of Funds

If the beneficiaries of the right kind and the right amount of education are expecting the colleges to do a good job for them, adequate funds must be provided from one or more of the following sources:

1. *Tuition and fees.* The amount of the tuition and fees varies greatly among the colleges. The tuition and fees may have to be increased in some colleges and decreased in others. In most instances the individual student bears this cost. Yet the student's tuition and fees rarely pay for as much as half the cost of his education.

2. *Endowments.* Drives are being planned, especially by the private colleges, to increase the endowment funds. The colleges will have to depend a great deal on an increase of donors of small gifts, and on the possibility of an increase in interest rates.

3. *Community aid.* Since the community is a top beneficiary of the quality education of its members, it should assume its due share of moral and financial support of the local college. Too many communities that are able to support their own colleges often ask for federal aid, thereby asking other communities to help carry their responsibilities.

4. *State aid.* Since state universities rarely have endowment funds, they must depend upon state appropriation for the major part of their support. Yet it is difficult to obtain adequate appropriations for the effective operation of the state universities from state appropriations alone.

5. *Federal aid.* At present federal aid is provided for the veterans who qualify under the G. I. Bill of Rights and for certain nation-wide areas of training and research that are of special importance to the country. The Federal Government pays for the direct cost of education of those veterans who qualify under Public Law 346 and Public Law 16; the "direct cost" is approximately sixty per cent of the total cost. The decrease in G. I. enrollment will reduce the income from Federal funds to such an extent that the colleges will have to look elsewhere for additional funds. Several

bills are now before Congress providing for a great expansion of Federal aid, which some individuals think might be the beginning of Federal control of our educational system.

The land-grant colleges and universities have been the beneficiaries of Federal aid for higher education for over seventy-five years, and at no time has this involved dictation on the part of the Federal Government. During the 1930's many colleges and universities were able to construct new buildings because of the financial aid from the Public Works Administration. These grants did not imply Federal control. Federal aid for specific nation-wide programs of training and research has been made available during the past several years to certain colleges and universities, with little or no Federal control. Federal aid to education is now requested by certain persons and groups because of: (1) the vanishing American dream of proper schooling for all who are qualified; (2) the inequalities of the income, or wealth, of various sections of the nation; and (3) the inadequacy of funds for education available from other sources.

Other persons and groups are opposed to increased Federal support of higher education because they fear the possibility of Federal control of education. The statement which follows is from a speech that General Dwight D. Eisenhower made in Albany, New York, on October 15, 1948:

> Because I believe that the Federal Government has no right to tax money out of our pockets and give it back to us without some form of supervision, therefore, I say that they cannot give federal money for the support of higher education. When federal money comes into that field, we are entering a dangerous situation.

6. *Aid from industry and business.* Many industries and businesses have provided some financial aid to colleges. Many would do much more if it were possible under state and national laws. Industries and businesses have made funds available: (1) to competent and needy students in the form of scholarships and fellowships; and (2) to the qualified colleges for educational and research projects.

7. *Aid from other sources.* Other organizations, such as trade associations, foundations, institutes, and labor groups, have contributed to education. These organizations should be encouraged to continue to do their part in the over-all program of quality education.

Cooperation of Industry and Business with Education

Because of the extensiveness of the topic, "The Financial Dilemma Facing the Colleges," the discussion must be limited to one phase of the problem. I should like to consider with you one source of the colleges' financial dilemma which I think is especially important: *the stake that industry and business have in education.*

Colleges and universities, both private and public, which have rendered recognized service to industry and business have enjoyed a cordial relationship with a large number of industrial and business organizations throughout the years. Educational institutions report very favorably on cooperation with industry and business and look upon it as a two-way process. They are prone, of course, to stress the services which they are prepared to render industry and business. But corporations which have worked with colleges and universities are also favorably disposed toward cooperation.

Most of the industrialists and businessmen are more or less aware of the financial problems confronting higher education, and many of them are asking questions such as the following:

1. Which colleges deserve financial assistance?
2. Can recognized accrediting agencies help to classify colleges?
3. Should preference be given to local institutions?
4. How much money is needed?

5. From which sources should funds be provided?
6. How much should each industrial and business organization contribute to supplement the income from other sources?
7. In what form or forms would financial aid be most effective?
8. Should there be restrictions on the funds donated?
9. Will the obligation be a continuing one?
10. How are the funds to be administered?

The several institutions of higher learning, both private and public, had better be prepared to be examined by the practical and realistic industrialists and businessmen. Each college should put its house in order and be able to give a constructive answer to the following questions:

1. How great is the future demand for the kind of persons being educated by this and similar colleges? Are the undergraduate curricula overspecialized?
2. Does this college operate on sound financial and academic policies?
3. Does it make maximum use of classrooms, laboratories, and other facilities on the basis of space and time?
4. Does it provide each of its students with friendly and helpful service and an individualized and humanized educational program, gauged to his preparation, learning rate, aptitudes, interest, and capacity, so that he can make the progress of which he is capable under experienced and inspired leadership?
5. Does it improve and develop each student who is admitted regardless of whether he remains in the college one or two years on a terminal program or four years on a program leading toward a degree?
6. Is it vitalizing its students with a motivating, active interest in and concern for the meaning of American freedoms and the responsibilities of good citizenship?
7. In which specialized fields is it adequately equipped to carry on research?
8. Is it well organized and adequately supervised?
9. Does it have a high grade, active, growing, and adequate teaching faculty and scientific research staff?
10. Does it have exceptional staff members in the key positions?
11. If this college is overexpanded and/or overstaffed, how shall this situation be remedied?
12. Does this college have definitive plans which justify future expansion?
13. Does it enjoy the respect of industrialists and businessmen?

Attitude of Industrialists

If the colleges do their part well, then the further question is—What is the attitude of industrialists and businessmen toward colleges in need of financial support? Permit me to quote several distinguished men who have the reputation of understanding the problems confronting industry, business, and education.

Mr. Laird Bell, an attorney of national repute, said in a recent address:

> If education does its part well, industry in contributing to education benefits both itself and education. This is, I believe, amply demonstrated by the fact that some twenty concerns, headed, incidentally, by the oil companies, have subscribed $3,000,-000.00 over a 5-year period for work in pure science in the Nuclear Institute of the University of Chicago. The National Industrial Conference Board has made a number of studies of corporate contributions. They found that 71 of the 100 largest manufacturing corporations gave over 16 million dollars to charity in 1947, while half of this went to community purposes and only a little over 2 millions went to education.[1]

[1] Bell, Laird (Chairman of the Board of Trustees, University of Chicago): "Co-

Mr. Frank W. Abrams, Chairman of the Board of Standard Oil of New Jersey, in a recent address acknowledged the debt that business and industry owe to education. He said in part:

If business and industry could not draw upon a large reservoir of educated manpower, they would be handicapped in every phase of their operations. American education does a job for business and industry. If our hope of an advancing American economy involves reducing costs, increasing individual productivity, and devising better ways of doing things, we must consider that we have a major interest in helping American educators in their work.[2]

It is my personal opinion that the peace, prosperity, and security of this nation may depend as much on the way we treat our teachers and our religious leaders as it does on any other single influence. We believe that the individual is important and should always come first. Colleges and universities are today more and more looking to business and industry for help—and I think they are right in doing so. More and more the corporate individual is being asked to assume some part of the responsibility that the private individual is not so well situated to carry with present taxes and surtaxes—and I think it is interesting and significant that corporation giving to various forms of philanthropy has increased tenfold in the past decade. I believe that the will to contribute exists very widely today in the field of business and industry, but I find that very few people (among them very few educators) are aware of the substantial obstacles to giving which the law puts in the path of the public spirited corporation management.[2]

Mr. John L. McCaffrey, President of International Harvester Company, declares that in education business has a "legitimate business interest at stake." In a recent address he said:

If we are to maintain and expand our educational system, we must do more than offer good wishes. We must give financial support to the limit of our abilities. We must give assistance by every other means possible.

Aside from our interest as individual citizens, we have a legitimate business interest at stake. Every businessman today needs to know enough about the society in which he lives and operates so that he can follow its changes intelligently, adjusting himself and his business to changing times, and making sure that his business serves its most useful purpose for society.[3]

Dr. Frank B. Jewett, President of the National Academy of Sciences, has said:

I urge that income tax credit under discussion be formulated in terms sufficiently broad to include private gifts to all agencies of higher learning, as well as to all lines of research and investigation carried on with them. This suggests as an initial goal a sum of 70 million dollars, which is less than 3% of the tax reduction now in contemplation for 1947–48. And when contributions from corporations are taken into account, the sum that is required from private givers becomes truly a very minor quantity in comparison with tax reduction. My proposal then is—that of the shortly-to-be-established tax reduction, Congress in effect channel approximately 2 to 3% to American scholarship, by the expedient of telling the taxpayer that he will get full tax credit (within limits to be set) for whatever contribution he makes to educational and scientific agencies. If he chooses not to make such a contribution, he may expect the tax collector to demand an equal sum of money.[4]

operative Planning for Education and Industry.'' Address delivered before the 1948 Texas Personnel Conference, November 5, 1948.

[2] Abrams, Frank W. (Chairman of the Board, Standard Oil Company of New Jersey): ''How Can American Business Help American Education?'' Address delivered before the Thirty-fifth Annual Meeting of the Association of American Colleges, January 11, 1949.

[3] McCaffrey, John L. (President of the International Harvester Company). Address delivered before the Convention of the American Bankers Association in Detroit, Michigan, September 29, 1948.

[4] Jewett, Frank B. (President, National Academy of Sciences): ''The Case for Continued Private Support of Fundamental Science,'' March 11, 1947. Presented before the Committee on Interstate and Foreign Commerce, Washington, D. C.

The following resolution was adopted at the 1948 Congress of American Industry and the National Association of Manufactures:

> The 53rd Congress of American Industry emphasizes industry's interest in education and calls upon all employers to initiate and promote closer ties between industry and education in their own communities, to give active leadership and personal support to the maintenance of adequate educational facilities and the compensation of teachers on a basis which is consistent with their professional stature.[5]

Nature of Financial Aid

There seems to be rather general agreement among the industrialists and businessmen that they want to render moral and financial support to worthy institutions of higher learning. Such assistance would be extremely helpful to colleges and universities, both private and public, in supplemental support of their wide range of activities in education, research, and public service. Many of the industrialists and businessmen have asked for suggestions on ways in which corporations and businesses may help finance sound education. The following means of assistance to colleges are offered for favorable consideration:

I. *Fellowships and grants.*
   1. Funds for basic and applied research.
   2. Funds for research fellowships.
   3. Provision for research equipment and materials.
   4. Loans of equipment and scientific apparatus.

II. *Scholarships.*
   1. Undergraduate scholarships given as outright and unrestricted gifts.
   2. Scholarships:
      a. For employees.
      b. For children of employees.
      c. For individuals in the community.

III. *Loan funds.*
   1. To worthy and needy students.
   2. To worthy and needy faculty members.

IV. *Outright and unrestricted gifts.*

V. *Services to professors.*
   1. Employment of professors at salaries they receive plus an extra amount to take care of increased family expenses:
      a. During summer vacation.
      b. During leave of absence.
   2. Greater use of college professors as consultants.
   3. Teaching fellowships.
   4. Awards to professors to stimulate good teaching.
   5. Opportunities for professors to visit plants at company expense.
   6. Establishment of schools for professors within the plants, to teach teachers how business really runs on a free enterprise basis.

VI. *Services to students.*
   1. Employment of students during summer vacation.
   2. On-the-job training in connection with college work.
   3. Opportunities for student groups to visit plants.
   4. Special awards to students, particularly in activities which stimulate inventiveness and self-expression.

VII. *Services to prospective students.*
   1. Promotion of interest in education among qualified high school students by local industries and businesses.

VIII. *Machinery and equipment.*
   1. Donations of machinery and equipment for laboratory and classroom work.

[5] Resolution adopted at the 1948 Congress of American Industry, National Association of Manufacturers, The Waldorf-Astoria, New York City, December 1, 2 and 3, 1948.

2. Loans of machinery and equipment for laboratory and classroom work.
3. Discounts on machinery and equipment sold to colleges.

IX. *Teaching aids.*

1. Gifts and loans of educational films and exhibits.
2. Provision of material for textbooks.
3. Provision of pamphlets describing production techniques, product specifications, and personnel requirements.

X. *Company specialists.*

1. Loans of research specialists to universities and colleges for scientific lectures.
2. Loans of production specialists for lectures on manufacturing.
3. Loans of personnel specialists for lectures on industrial relations.
4. Loans of administrative specialists for lectures on company policy.

XI. *Extension service.*

1. Assistance in organizing extension classes.
2. Provision of facilities for extension laboratories and classrooms.
3. Cooperation in providing postgraduate programs for employed college graduates.

The right kind of colleges and universities, both private and public, which show leadership, imagination and initiative, will give the most efficient service to their students with whatever funds are available. The increasing waste of our intellectual resources can be avoided only through the use of additional funds. Funds from the communities, churches, states, individuals, unions, trade associations, institutes, foundations, and federal government support in emergency and for certain areas of training and research of a national scope, supplemented by whatever funds industry and business wish to invest in education, should make it possible to provide the right kind and the right amount of education to each citizen. We shall pay disastrous penalties if educational neglect is continued.

Colleges and universities welcome and appreciate a growing recognition on the part of industrialists and businessmen that a progressive educational system has been, and will always continue to be, vital to our American business and industry.

College Notes

The **Foundry Educational Foundation,** which conducts a college level educational program for the entire foundry industry in seven engineering schools, will expand its program to include five more colleges in 1950. During its first three-year cycle, the Foundation awarded 148 scholarships of one year each to 102 students, some of whom received more than one unit.

The Foundation's program is in effect at Massachusetts Institute of Technology, Cornell University, University of Wisconsin, Case Institute of Technology, University of Cincinnati, Northwestern University, and the University of Alabama. Next year it will include Ohio State University, Purdue University, Michigan State College, Pennsylvania State College, and the University of Missouri School of Mines and Metallurgy.

Paul R. Trumpler, of Olean, N. Y., has been appointed professor of mechanical engineering at **Illinois Institute of Technology,** Professor Frank D. Carvin, director of the department, announced today.

Engineering Mission to Latin America *

By S. S. STEINBERG

Dean, College of Engineering, University of Maryland

This paper is a sequel to the one entitled "Engineering Education in Latin America" (JOURNAL OF ENGINEERING EDUCATION, Vol. 37, No. 4, December, 1946). The first paper described the writer's observations on a tour during the summer and fall of 1945 through twelve of the republics of Latin America under the auspices of the U. S. Department of State. The present paper presents similar observations during the summer and fall of 1948 under the same auspices and covers the eight remaining countries south of our border. This engineering mission to Latin America was the first ever undertaken to determine by personal observation the status of engineering education, the engineering profession, and engineering projects, in all twenty other American republics. On both tours, the writer was privileged to serve as the official representative of the engineering schools as well as of the engineering societies of the United States to the corresponding groups in the Latin American countries.

* Paper presented at the 57th Annual Meeting of the American Society for Engineering Education, Troy, New York, June 20–24, 1949.

EDITOR'S NOTE: *This is the second paper by Dean Steinberg resulting from his mission as our Society's Ambassador of Good Will to the 20 other American republics. The success of his ambassadorship is indicated by the fact that during the course of his travels he was named an honorary professor of eight Latin American national universities and an honorary member of an equal number of engineering societies.*

Engineering Schools Visited

Following is a list of the engineering schools visited on the second tour presented in the order in which they were inspected. The accompanying map locates the schools geographically. Six of the countries are in the Caribbean area while the remaining two, Bolivia and Paraguay, are both land-locked in the very heart of South America.

Guatemala
University of San Carlos, Guatemala City

El Salvador
University of El Salvador, San Salvador

Honduras
Central University of Honduras, Tegucigalpa

Nicaragua
Central University of Nicaragua, Managua

Bolivia
University of San Andreas, La Paz
Technical University of Oruro, Oruro

Paraguay
National University of Paraguay, Asuncion

Dominican Republic
University of Santo Domingo, Ciudad Trujillo

Haiti
University of Haiti, Port-au-Prince

The eight countries visited on the second tour are, in general, the Latin American republics that are the least developed

economically and from the engineering point of view; they are, therefore, those that are in greatest need of the services that only the engineer can provide, namely, highway and railroad transportation, sanitary and health facilities, the development of agricultural and mineral resources, and, finally, industrialization. There is one engineering field in these regions in which progress has been rapid and phenomenal, namely, in air transportation. Aviation has opened up vast interior areas that previously were inaccessible on account of great physical barriers, and has served to put them in direct contact with the outside world. There are still many natives in interior fastnesses in the southern part of the

DATA ON ENGINEERING SCHOOLS VISITED IN 1948

Country	University and Engineering School	No. of Students Male	Female	Total	No. of Faculty	Courses Offered	Course in Yrs.	Yr. Present Engrg. School Founded or Reorganized	Remarks
Guatemala	University of San Carlos Faculty of Engineering	298	13	311	24	C.E.	6	1922	Class hours: 7–9 A.M.; 5–7 P.M.
El Salvador	University of El Salvador Faculty of Engrg. and Arch.	148	2	150	22	C.E.	5	1927	Class hours: 8–12 M.; 2–5 P.M.
Honduras	Central University of Honduras Faculty of Phys. Sci. and Math.	79	3	82	18	C.E.	5	1904	Require additional year practice and thesis.
Nicaragua	Central University of Nicaragua Faculty of Engineering	49	1	50	22	C.E.	5	1941	Class hours: 6:30–8 A.M.; 12M–6 P.M.
Bolivia	University of San Andres Faculty of Exact Sciences	76	1	77	46	C.E. Ind. E.	7 7	1940 (C.E.) 1943 (Ind. E.)	Data given excludes Arch.
	Technical University of Oruro National School of Engineering	248	2	250	13	C.E. E. Mines	6 6	1905	Has full-time faculty
Paraguay	National University of Paraguay Faculty of Math. and Phys. Sci.	46	4	50	18	C.E.	6	1926	Class hours: 2–7 P.M.
Dominican Republic	University of Santo Domingo Faculty of Exact Sciences	290	10	300	20	C.E. Arch. E.	5 5	1914	University founded in 1538
Haiti	University of Haiti School of Engineering	62	0	62	27	C.E.	4	1947	School of Applied Sciences founded in 1902

hemisphere who have never seen a railroad train or an automobile but who feel perfectly at home at an airport.

The efficiency of air transportation in these countries made possible the wide area coverage by the writer in a comparatively short space of time. On his two trips, he travelled a distance of approximately 32,000 miles in a total period of six months, with sufficient time available to see and to observe in each country most of its activities related to engineering and engineering education.

Data on Engineering Schools

The accompanying tabulation gives certain data on each of the engineering schools visited by the writer in 1948. These include enrollment, faculty, courses and hours of instruction. It will be observed that the faculty members are practically all on a part-time basis and the hours of instruction are arranged to fit the climate and to suit the convenience of both faculty and students, all of whom are otherwise gainfully employed. The salaries paid the members of the engineering teaching staff are pitifully small. For a class taught three times a week, the monthly compensation is $40 in Guatemala, $50 in El Salvador, and only $20 in Honduras.

While individual variations exist in the engineering schools in the different countries, depending upon the length of the course and the special local requirements, the following is a typical curriculum of six years duration:

Course of Study leading to degree of Civil Engineer:

	Hours per Week
Pre-Engineering Course	
Trigonometry	6
Advanced Algebra	3
Mathematical Physics	6
General Chemistry	6
Descriptive Geometry	6
Geometric Drawing	3
Total	30

	Hours per Week
First Year	
Analytic Geometry	3
Infinitesimal Calculus I	3
Specialized Chemistry	6
Geology	6
Surveying	6
Topographical Drawing	3
Total	27
Second Year	
Technical Mechanics	6
Infinitesimal Calculus II	3
General Hydraulics	6
Advanced Surveying	6
Geodesy	6
Mechanical Drawing I	3
Total	30
Third Year	
Structures I	6
Electrotechnics	6
Building Materials	3
Civil Constructions I	6
Sanitary Engineering	6
Mechanical Drawing II	3
Total	30
Fourth Year	
Structures II	6
Mechanical Engineering	3
Electrical Engineering	3
Reinforced Concrete	6
Highways	6
Civil Constructions II	6
Total	30
Fifth Year	
Bridges	3
Estimates and Specifications	3
Aesthetics of Construction	3
Statistics	3
National Economics	3
Engineering Contracts	6
Total	21
Grand Total	168

Projects

A minimum of 6 months of practical work is required.

In addition to the curricula listed in the tabulation, most of the engineering schools offer a two-year course for Surveyors. This course usually comprises

the first two years of the regular Civil Engineering curriculum.

Economic Considerations

Although each of these countries maintains an engineering school, in many of them the facilities for engineering instruction are very meagre. In some cases, laboratories are non-existent. Some do not even possess the most elementary laboratory facilities in Chemistry, Physics, or other fundamental courses and yet engineering degrees are awarded annually. The instruction is wholly theoretical, is based largely on mathematical theory and, in general, is unrelated to practical engineering work. The reasons for the low status of the engineering schools in these countries is almost wholly economic. With some exceptions, the mass of the population is illiterate, under-paid, under-fed, and often indifferent as to its own status. Public works are meager, yet the need for them in almost every field of engineering is very great. Most of the countries abound in rich natural resources, largely untapped, but which, if developed, could provide profitable employment for the native population and bring great benefits to the country. The lack of engineering development in some of the countries is due to poverty, to political instability, to adverse topography, to climate, to lack of local incentive, to lack of security for investment of foreign capital, to the scarcity of engineers, and to failure to establish a policy regarding public improvements that are so greatly needed.

In most of these countries, the officials who have control of the universities and the engineering schools realize the need for improvement of their faculties and their facilities, but in most cases they are unable to do much about it because of local economic factors. Others have recognized the need for trained engineers and have undertaken projects to improve their physical facilities. Several countries have plans in various stages of completion, or have already built a "Ciudad Universitaria," or "University City," which corresponds to our campus.

Examples of Progress

The University of San Andres, in Bolivia, has followed the pattern of the University of Pittsburgh in erecting a handsome twelve-story building, the tallest in La Paz, the highest capital in the world. It is located in the Andes mountains at an altitude of more than 12,000 feet. The height of the University structure, which by law no other building in the city will be permitted to reach or to exceed, symbolizes the high place of education in the life of the Republic. The writer was interested to observe on his inspection of this building that six of the twelve stories are assigned to engineering and allied departments.

The University of Santo Domingo, in the Dominican Republic, has similarly made excellent progress. It has already erected six modernistic, spacious buildings on a beautiful site on the outskirts of Ciudad Trujillo, the capital. Thus far, no building has been erected for the Faculty of Exact Sciences (Engineering), which is temporarily housed in the unit belonging to the Faculty of Dentistry. The plans for an engineering building have been completed and it is hoped funds will soon be provided for its construction. The University of Santo Domingo is claimed to be the first institution of higher learning in the western hemisphere, having been authorized by Papal Bull on October 28, 1538, a century before the founding of Harvard University, the oldest in the United States. This University is located in a land that is the cradle of civilization in this hemisphere. It is on an island discovered by the Great Admiral, Christopher Columbus, and where, by his own request, his mortal remains are today.

With the two exceptions just noted, all the remaining engineering schools in this group are in great need of new buildings; but, what is more important, they are in greater need of laboratory equipment, as previously noted.

The Faculty of Engineering at the Technical University of Oruro in Bolivia is unique in several respects. It is located at an elevation of 13,500 feet. Of the nine engineering schools visited on the second tour, only this school has a full-time faculty, and they are justly proud of that fact. The only other engineering school in this category in Latin America is that at the Central University of Venezuela visited on the first trip. The members of the Oruro engineering faculty are prohibited by law from engaging in outside professional activity. While the Oruro school does not have the advantage of the large income from petroleum resources possessed by the engineering school in Venezuela, it does own a mine which produces principally silver and lead, the income from which goes to the engineering school and makes possible the full-time faculty.

Suggested Plan

In discussing with many of the leaders in these countries the great need for properly trained engineers, the writer has suggested the possibility of utilizing some of the military budgets and military schools for this purpose. The plan suggested was to arrange the training in the military schools so as to include engineering fundamentals in addition to military science. Then students qualified by mathematical and scientific ability could, upon graduation, as in the case of our own West Point, enter upon engineering public works, and thus furnish a supply of engineers so greatly needed. As in all countries these days, the military budget is the largest of all governmental expenditures. If some of these funds could be allocated and expended annually on a priority basis for laboratory equipment necessary for proper engineering instruction, great benefits could accrue to the entire country. Under this plan, military men could be of great service to their countries in time of peace and not be dependent wholly for utilization of their abilities in time of war. Several of the military leaders looked with favor upon this proposal, and it is possible that the plan may be tried soon in at least two of the republics.

The Engineering Profession

The engineering profession in these countries recognizes the deficiencies that exist in their engineering education and they are anxious to cooperate in every way that will further education and professional advancement. Each of the eight countries visited, except Nicaragua, maintains an active engineering society which is working closely with its faculty of engineering. Almost all the engineering teachers are practicing engineers and are members of these societies.

Following is a list, arranged alphabetically by country, of the engineering groups visited by the writer on his two tours. It was his pleasure to address and to be delightfully entertained by 24 principal engineering societies located in 19 countries:

Argentina
- Argentine Society of Engineers, Buenos Aires

Bolivia
- Society of Engineers of Bolivia, La Paz

Brazil
- Institute of Engineers of Sao Paulo
- Engineers Club of Rio de Janeiro
- Brazilian Engineering Federation, Rio de Janeiro
- Engineers Club of Pernambuco Recife
- South American Union of Engineering Societies, Rio de Janeiro (1948)

Chile
- Institute of Engineers of Chile, Santiago

Colombia
- Society of Engineers of Colombia, Bogota

Costa Rica
- Society of Engineers of the Republic, San Jose

Cuba

Cuban Society of Engineers, Havana

Dominican Republic

Dominican Society of Engineers and Architects, Ciudad Trujillo

Ecuador

Society of Engineers of Ecuador, Quito

El Salvador

Society of Engineers of El Salvador, San Salvador

Guatemala

Association of Engineers of Guatemala, Guatemala City

Haiti

Haitian Association of Engineers and Architects, Port-au-Prince

Honduras

Society of Engineers of Honduras, Tegucigalpa

Mexico

Association of Engineers and Architects of Mexico, Mexico City

Nicaragua

Has no organized engineering society

Panama

Society of Engineers of Panama, Panama City

Paraguay

Paraguayan Society of Engineers, Asuncion

Peru

Society of Engineers of Peru, Lima

Institute of Mining Engineers of Peru, Lima

Uruguay

Association of Engineers of Uruguay, Montevideo

South American Union of Engineering Societies, Montevideo (1945)

Venezuela

Society of Engineers of Venezuela, Caracas

Engineering Cooperation

The writer was greatly pleased to note on both tours the splendid contributions to the progress of the Latin American countries made by several of our own government agencies in the development of education, transportation, sanitation, and health. These engineering accomplishments have already served in each country as excellent object lessons of the contributions that the engineering profession can make to the health, the happiness and the economy of the nation. It was particularly gratifying to be told by native engineers, physicians, ministers of public works, and even by several presidents of the republics visited, how much they appreciate what has been accomplished through our cooperative efforts. Following is a brief summary of some of these outstanding projects inspected by the writer in his travels.

Inter-American Highway. This highway extends from Laredo, Texas, through Mexico and the six Central American republics to the Panama Canal, a distance of approximately 3300 miles. Work on the portion of this highway traversing Mexico is directed and financed entirely by the Mexican government. In the Central American republics, the United States government, through the Public Roads Administration, has been cooperating for several years with these countries in financing and building the highway. All construction work is performed by local labor, while the employees from the United States are small in number and fill engineering, administrative and accounting positions.

The status of the Inter-American Highway at the beginning of 1949 is that it is passable either on paved all weather, or on dry weather roads most of its length. This is true through all of Mexico, except for some 60 to 70 miles north and south of the Mexico-Guatemala border; through Nicaragua except for 33 miles; and for all of the remainder of the highway except for about 100 miles north and south of the Costa Rica-

Panama border. When the Inter-American highway is open for its entire length, the motorist will be able to traverse one of the most spectacular roads in the world. He will be able to travel from the steaming jungles of the tropics, across cool plateaus, and then climb to the top of a cold mountain range in Costa Rica which is crossed at an elevation of 11,000 feet.

Many advantages have accrued to the other American republics through United States participation in this work. The highway has provided transportation facilities where formerly none existed; has opened up new areas with untapped resources; has served to promote advancement of agriculture, industry, and commerce; has brought together the peoples of neighboring countries who before highway or air transportation was available, were neighbors in name only; and finally, has assisted in the development of a skilled highway organization in each of the countries with engineers, supervisors, and workmen obtaining experience in actual construction.

In addition to its cooperative activities in Central America, the Public Roads Administration has provided engineering advice and assistance on highway projects to the governments of Bolivia, Dominican Republic, Ecuador, Haiti, and Venezuela.

Institute of Inter-American Affairs. The health and sanitation program of this Institute started in 1942, and operates under cooperative agreement between the United States and most of the other American republics. It is designed to aid and improve the health and general welfare of the people of the western hemisphere. Agreements have been completed, or are now in operation, in all the countries to the south except Argentina and Cuba. These cooperative undertakings have illustrated the great benefits that can accrue to a country when the physician and the engineer pool their professional knowledge.

The projects include construction or improvement of medical and public health facilities, including hospitals and dental and other clinics; sanitation, including water supplies, sewerage systems, and community sanitation facilities; health centers and laboratories, including health education, immunization, malaria, hookworm, yaws, and rat control; and training of technicians in public health and sanitation activities, including physicians, nurses and sanitary engineers, who are trained in graduate schools in the United States or through courses conducted within the countries.

Each project is housed in an attractive, comfortable building designed to harmonize with the local architecture, and constructed of local materials. The costs are shared by both cooperating governments. After project facilities are constructed, their operation and maintenance becomes a function of the municipality.

The writer had the privilege on both tours of observing the construction and operation of many of the projects sponsored by the "Servicio," as it is familiarly known south of our border. Reviewing the second tour only, he inspected such widely diverse projects as the 1000-bed national hospital under construction in Guatemala City; the municipal slaughterhouse and the municipal public laundry in San Salvador, and the sewage treatment facilities at Santa Tecla, both in El Salvador; the water supply system and the tuberculosis hospital in Tegucigalpa, in Honduras; the new sanitary engineering laboratory at the University of San Andres, and a similar one at the Technical University in Oruro, both in Bolivia; the health centers and dispensaries in Asuncion, as well as the construction for the leper colony at Sapucay, both in Paraguay.

Due to these cooperative activities and the stimulus supplied by the Institute of Inter-American Affairs, practically all the engineering schools in the countries visited on the second tour are giving greater attention than heretofore to instruction in Sanitary Engineering. In some of the schools this specialty is being offered as an option in the final

year of the Civil Engineering curriculum.

Some of the other cooperative projects with agencies in the United States that have brought great benefits to the other republics include the Inter-American Geodetic Survey, in their extensive mapping projects; the United States Coast and Geodetic Survey, in training personnel; the advanced training program for highway engineers sponsored by the American Road Builders' Association; and many others.

Pan American Engineering Congress

As a direct result of the personal contacts established with the engineering schools and engineering societies in the other American republics, the First Pan American Engineering Congress has been called to meet in Rio de Janeiro, Brazil, in July, 1949. The Congress is being sponsored by the South American Union of Engineering Societies, and in this country, by the Engineers Joint Council, composed of the representatives of our major national engineering societies, whose Committee on International Relations has taken a very active part in planning for the Congress and in arranging for United States participation. This Congress will be the first in this hemisphere to be inclusive of all branches of the profession and will bring together for the first time representatives of engineering societies, engineering educators and engineering research organizations of the three Americas. Preceding the Congress there will be a meeting in Sao Paulo, Brazil, at which the groundwork will be laid for the creation of a Pan American Union of Engineering Societies for the entire hemisphere. The Pan American Engineering Congress offers an opportunity of putting into immediate effect the recommendations of Point Four of President Truman's inaugural address which proposes to make available engineering know-how of the United States to other countries which are in great need of this knowledge to improve their present economic status.

Looking into the future, it may be that supplying this technical knowledge to other lands will require training in our engineering colleges fully as broad in the technical fields as now, but probably with a broader basis in the humanistic-social field, aiming toward living and working in foreign fields. The opportunity now exists, as never before, for the engineering profession of the three Americas to work together to the end that from such cooperation there may result lasting benefits to the peoples of all countries of the hemisphere. In this way we can contribute our share to the world's present greatest need, which is a firm and lasting peace.

College Notes

Appointment of two professors to the faculty of Division of Engineering at **Iowa State College** was announced by Charles E. Friley, president. George R. Town, formerly manager of Engineering and Research, and assistant secretary of the Stromberg-Carlson Company, has been named professor of electrical engineering and associate director of the Engineering Experiment Station. He replaces J. D. Ryder, who resigned to become head of the electrical engineering department at the University of Illinois.

David F. Smith was appointed professor of chemical engineering, and will, in addition, serve as senior chemical engineer in the Institute for Atomic Research. Smith was director of research development and control and a member of the board of directors of Johnson and Johnson from 1942 until coming to Iowa State. He directed a broad program in such fields as rubber, resins, plastics, paper, textiles, adhesives, cosmetics, pharmaceuticals, and new drugs.

Academic Calendars

By D. B. PRENTICE

Director, Scientific Research Society of America, New Haven, Conn.

The question of whether to assign four or five years to the undergraduate engineering curriculum has been argued many times, and opinion is still divided, with the majority favoring four years. The plan of six or seven years for a combined arts college and engineering school program has a few supporters and some cooperative curricula offer the equivalent of four and a half or five years of academic work. The four year period, however, has held its own for a century as the most popular schedule leading to the bachelor's degree. Variations have come and some have remained but probably ninety per cent of the accredited engineering curricula currently require four years.

Academic years are traditionally divided into terms or semesters. Frequently the time table of the engineering school must conform to that of the university. However, independent engineering schools are not unanimous in preferring either two or three divisions of the college year. In general the total weeks are the same and thirty-six seems to be a fairly standard length. Three twelve-week terms or two eighteen-week semesters are generally accepted, although seventeen and even sixteen week semesters are used by a few institutions. Semesters are preferred by those who object to short courses, and terms appeal to those who like to finish course examinations before the Christmas holidays. Inasmuch as the date of Easter varies from year to year there is no corresponding regular annual advantage at the end of the winter term.

Educational institutions have been criticized for inefficient use of plant and equipment because of the long summer vacation. There is good reason for a short holiday period at Christmas and perhaps a few days in early spring. Sustained mental effort, which should be demanded of students in college, is fatiguing and periodic interruptions probably improve the performance of learners and teachers. A three-month interval between spring and fall semesters or terms, however, is hardly necessary for recuperation.

Arguments for the summer vacation include opportunity to earn part of college expenses for the students and to carry on research or secure industrial experience for the faculty. In many cases the first is not necessary and the second is not done. In fact the majority of students do not seek summer jobs and the majority of teachers do little full time research.

It is true that many institutions operate summer terms, which provide extra compensation for the faculty and opportunities for the students to shorten the total calendar time required to complete degree requirements. A few institutions now make faculty contracts on the basis of the normal academic year plus a short summer session or a full summer session in alternate years. Salaries can be higher under this plan and a reasonable amount of time is still available for research. But no accredited college, so far as the writer knows, deliberately schedules full academic time of its students. All required engineering curricula are limited to thirty-four or thirty-six weeks of classes between September and June with extra summer work optional, except for surveying or similar practice courses

in one or two of the undergraduate years and the alternating academic periods of the cooperative program.

On a time basis, therefore, the standard academic program is less than seventy per cent efficient. It probably reflects a carry-over from the days when the United States had an agricultural economy and "working on the farm" was essential. The short college year is characteristic in all countries and in each case doubtless derives historically from the same agricultural labor requirement. At least in the United States this demand no longer exists.

Is it possible to arrange a time-table that retains the advantages of the present standard and avoids its inefficiencies? The following simple adjustment is offered as a solution; three fifteen-week terms, a ten-day holiday at Christmas, a four-day interruption in the spring, and five weeks of vacation in the summer. For 1948–49 this calendar would have been as follows;

Fall term, Sept. 9–Dec. 22
Christmas holiday, Dec. 23–Jan. 2
Winter term, Jan. 3–April 15
Spring holiday, April 16–April 20
Spring term, April 21–Aug. 3
Summer vacation, Aug. 4–Sept. 7
Fall term, Sept. 8–Dec. 21
Christmas holiday, Dec. 22–Jan. 1

The advantages of this calendar can be summarized as follows;

A. time efficiency of 86.5 per cent; forty-five weeks of school in each calendar year.
B. terms of nearly semester length, thus avoiding short courses.
C. fall term final examinations completed before Christmas holidays.
D. five weeks vacation in the vacation season. Time enough for travel or some concentrated research.
E. fall term commencing after Labor Day and corresponding to football season.
F. completion of requirements for first degree in three calendar years.
G. higher salaries for faculty.

While eighteen-week semesters can be considered standard a number of accredited engineering colleges operate on seventeen-week periods. Eight semesters of seventeen weeks each total 136 weeks. Nine terms of fifteen weeks each total 135 weeks; which may be considered practically equivalent to the former.

If a week per term be allowed for examinations the engineering course of twelve twelve-week terms has 132 weeks of instruction. The proposed schedule allows for 126 weeks with one-fourth less terminal points; not a dangerous reduction.

If it is felt that the present undergraduate curriculum should be lengthened the proposed time-table makes that feasible without taking more years of the student's life. For example, eleven terms can be completed and commencement held by late April of the fourth year after graduation from high school. Students from this schedule would thus have a slight advantage job-wise over those on the standard program. And they would have had 165 weeks of instruction, an increase of 15 to 20 per cent over the normal requirements.

An alternative arrangement would make the undergraduate curriculum ten terms, or 150 weeks, long and two terms, or thirty weeks, of instruction could be at the graduate level. This plan would permit the student to secure bachelor's and master's degrees in but little more total time than is normally required for the first degree.

The three 15-week term plan has received one criticism which can hardly be considered serious; the freshman, sophomore, junior, senior labels do not fit nine terms or three years. I imagine the undergraduates might be permitted to solve that problem.

The financial readjustments of a longer academic year are interesting, especially

to the faculty. It seems reasonable to charge the same tuition for work leading to the bachelor's degree whether offered in 8 semesters or 9 terms. For example, if tuition is \$225 per semester a student pays \$450 a year or \$1800 for his entire course. Under the proposed plan the equivalent tuition would be \$200 per term or \$600 a year.

Let E stand for endowment income per student per year, A for administrative and general expense and O for operating and maintenance expense per faculty member per year; both on the normal two semester basis. Assume a 10 to 1 ratio of students to faculty, a fixed student capacity and let F equal average faculty salary. The operating equation, assuming no profit or loss, is for each faculty member:

$$10E + 10 \times 450 = A + O + F. \quad (1)$$

For three 15-week term operation the items A and O will increase only slightly; for heating load, care of grounds, etc., will not change and most operating and administrative personnel are on an eleven month basis anyway. Assuming a 10 per cent increase in these items we get equation

$$10E + 10 \times 600 = 1.1A + 1.1O + F'. \quad (2)$$

Subtracting (1) from (2) we get

$$1500 - \frac{A+O}{10} = F' - F. \quad (3)$$

If teaching salaries are two-thirds of the total educational budget, then $A + O$ must equal $F/2$.

Substituting in (3) we get:

$$1500 - F/20 = F' - F,$$

or

$$F' = .95F + 1500. \quad (4)$$

This represents an increase for any salary average less than \$30,000. For an average salary of \$5000 (instructor to professor, weighted) the proposed change indicates a possible increase of \$1250 per year in the average, or one-fourth. A change of the average by this amount could mean, in a faculty of normal rank distribution, increases in salary of \$2100 for professors, \$1000 for assistant professors and \$700 for instructors.

Before	
10 professors @ \$7000	\$70,000
8 asst. prof. @ \$4750	38,000
12 instructors @ \$3500	42,000
30 @ \$5000	\$150,000
After	
10 professors @ \$9110	\$91,100
8 asst. prof. @ \$5750	46,000
12 instructors @ \$4200	50,400
30 @ \$6250	\$187,500

Under the suggested plan there will be three classes in college instead of four. This means three-fourths as many subjects to be taught simultaneously with one-third more students in each. In general this should mean more efficient use of faculty time. Possibly the gain would permit equally satisfactory instruction with, say, a 12 to 1 student-faculty ratio. The further possible increase in salaries is calculated below:

$$10E + 4500 = A + O + F. \quad (1)$$

$$12E + 12 \times 600 = \frac{1.1 \times 12}{10}(A + O) + F''. \quad (5)$$

Subtracting (1) from (5) we get

$$2E + 2700 = .32(A + O) + F'' - F. \quad (6)$$

Substituting for $(A + O)$

$$2E + 2700 = .16F + F'' - F$$

or

$$F'' = .84F + 2E + 2700. \quad (7)$$

Substituting \$5000 for F and \$300 for E,

$$F'' = 4200 + 600 + 2700 = \$7500. \quad (8)$$

The resulting average salary is an increase of \$2500 or 50 per cent. The

distribution of salaries then might take the following form:

10 professors @ $11,100	$111,000
6 asst. prof. @ $6000	36,000
9 instructors @ $4500	40,500
25 @ $7500	$187,500

It should be noted that smaller values of E, and therefore of F, will produce larger relative increases in faculty salaries. This is to be expected, of course, as endowment income is not affected by time-tables or student faculty ratios.

Perhaps the suggested change from a 10-to-1 to a 12-to-1 ratio requires analysis. Assuming a unit of 300 students the change would decrease faculty from 30 to 25. With the average student distribution among classes of approximately $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, and $\frac{1}{3}$ from senior to freshman year we would have classes about as follows: seniors, 50; juniors, 60; sophomores, 75; and freshmen, 100. Each of these groups must be increased slightly to give a total of 300. If 20 students are considered a maximum per section for instruction we shall have a minimum of 5 sections of freshmen, 4 of sophomores, and three each of juniors and seniors, a total of 15. Irregularities of enrollment may increase this to, say, 20 sections. If the students' schedules average 18 credits with 14 recitations and four 3-hr. laboratory or drawing periods per week as a typical distribution, we get a clock-hour teaching load of $20 \times 26 = 520$. For a faculty of 30 the average individual clock-hour teaching load would be 17.3 per week with an average student-hour teaching load of about 260.

Assuming the proposed calendar of three 15-week terms per year and the same total enrollment we might get a distribution of 67 seniors, 99 middlers and 134 freshmen. Irregularities would be relatively less important and we might have 4 senior, 5 middle and 7 first-year sections, or a total of 16. With the same schedule requirement as before we get a total clock-hour teaching load of $16 \times 26 = 416$. For a faculty of 25 the average individual clock-hour teaching load would be 16.7 per week.

The suggested three 15-week term year has been considered informally by a few engineering college teachers, but, so far as the writer knows, has never been adopted by a faculty. It seems to have enough advantages to merit discussion. Time does not permit the presentation of a specific sample curriculum for nine terms; but one advantage is immediately obvious, for mathematics can be finished in the first three periods.

College Notes

Because of the vastly expanding national program of irrigation and reclamation there has been under development during the past several years at **Colorado A. & M. College** an Irrigation Institute with the objective of offering graduate training in all phases of irrigation engineering. The favorable location of the College among the irrigated areas of the West, and the long and noteworthy experience of the irrigation staff, combine to form a unique opportunity for advanced study and research. Integrated with this program is the work being done in the Hydraulics Laboratory, which was formerly used by the U. S. Bureau of Reclamation in connection with the studies for Hoover, Grand Coulee, Norris and other notable dams. Dr. Maurice L. Albertson is in charge of work in the hydraulics Laboratory. The Civil Engineering Department of the Engineering Division, which administers the graduate work in irrigation engineering, is under the direction of Dr. Dean F. Peterson, who just came to A. & M. College from Utah State College.

The Role of Universities and Colleges in Research as Reflected by the Steelman Report

By N. A. CHRISTENSEN
Director of School of Civil Engineering, Cornell University

Introduction

The impact of the recent war has convinced practically all thoughtful Americans that our future welfare, both in time of peace and in time of war, depends upon our research accomplishments. This fact is evident from four important investigations each resulting in reports: first, Dr. Bush's report entitled "Science the Endless Frontier," second, by the extensive hearings in Congress on the National Science Foundation Bills, third, by the Steelman Report entitled "Science and Public Policy," and fourth, by the more recent report of the President's Commission on Higher Education. It is true that the last mentioned report has a somewhat broader concern than science alone. Its attitude of viewing the entire citizenry of the United States as our most fundamental resource is no doubt correct. But, this report like the others emphasizes the overwhelming importance of a vigorous scientific advance.

The Steelman Report was prepared by the Presidential Research Board composed of Reconversion Director John R. Steelman as Chairman and the Secretary of Commerce, the Secretary of the Interior, the Secretary of the Navy, the Secretary of War, the Federal Loan Administrator, the Chairman of the Federal Communications Commission, the Chairman of the Tennessee Valley Authority, the Chairman of the National Advisory Committee for Aeronautics, and the Director of the Office of Scientific Research and Development as members of the committee. Because of the membership of this Board, this report may be considered as a recommendation of the Executive branch of our government of the essential features of the research expansion proposed in the United States. The outcome of the recent election which returned the governmental control to the Democratic Party has increased the probability that this report will serve as a basis for legislation which will implement federal expansion of the research in the United States.

The Steelman Report entitled "Science and Public Policy" is composed of five volumes, totaling about 1000 pages. Volume one entitled "Science and Public Policy" is a summary of the basic recommendations and investigations of the committee.

Volume two entitled "The Federal Research Program" is a composite of several more detailed reports, one from each of the various federal agencies engaged in research. The relative importance of each of these agencies in the year 1947 can be seen by examination of the following table taken from Volume 2.

Volume 3 entitled "Administration for Research" is also a composite of reports one from each of the federal agencies having the responsibility of administration of research activities. The scope of the federal program is indicated by the following table taken from this volume.

Research and Development Agencies

A. Agriculture Department
1. Office of Experiment Stations.
2. Bureau of Animal Industry.
3. Bureau of Dairy Industry.

FEDERAL RESEARCH EXPENDITURES, BY AGENCY, FISCAL YEAR 1947
(In thousands)

Agency	Expenditures	
	Amount	Per cent of total
Grand Total	$623,930	100.0
Navy Department	262,000	42.0
War Department	237,000	38 0
Agriculture Department	31,328	5.0
Interior Department	30,358	4.9
National Advisory Committee for Aeronautics	27,000	4.3
Federal Security Agency	13,236	2.1
Commerce Department	10,494	1.7
Federal Loan Agency (RFC)	4,699	.8
Tennessee Valley Authority	3,654	.6
Veterans' Administration	2,523	.4
Federal Works Agency	822	.1
Smithsonian Institution	309	(1)
Treasury Department	220	(1)
Federal Communications Commission	200	(1)
Maritime Commission	87	(1)

[1] Less than 0.05 per cent.

4. Bureau of Plant Industry, Soils, and Agricultural Engineering.
5. Bureau of Entomology and Plant Quarantine.
6. Bureau of Human Nutrition and Home Economics.
7. Bureau of Agricultural and Industrial Chemistry.
8. Agricultural Research Center (Beltsville).
9. The Forest Service.
10. Soil Conservation Service.
11. Production and Marketing Administration.
12. Farm Credit Administration.

B. Commerce Department
1. National Bureau of Standards.
2. Civil Aeronautic Administration.
3. Weather Bureau.
4. Coast and Geodetic Survey.
5. Office of Technical Services.

C. Department of the Interior
1. Geological Survey.
2. Bureau of Mines.
3. Fish and Wildlife Service.
4. Bureau of Reclamation.
5. National Park Service.

D. Navy Department
1. Office of Naval Research.
2. Bureau of Aeronautics.
3. Bureau of Yards and Docks.
4. Bureau of Medicine and Surgery.
5. Bureau of Ships.
6. Bureau of Ordnance.

E. War Department
1. Army Technical Services
   a. Quartermaster.
   b. Signal Corps.
   c. Ordnance
   d. Chemical.
   e. Engineers.
   f. Medical.
   g. Transportation.
2. United States Air Forces [1]
   a. Air Materiel

F. Federal Security Agency
1. U. S. Public Health Service.
2. Food and Drug Administration.

G. National Advisory Committee for Aeronautics
1. Lanley Memorial Aeronautical Laboratory.
2. Ames Aeronautical Laboratory.
3. Flight Propulsion Research Laboratory.

H. The Smithsonian Institution
1. Research Divisions.

I. Atomic Energy Commission
1. Research Division.

J. Federal Works Agency
1. Public Foods Administration.

K. Federal Communications Commission
1. Engineering Department.

L. Federal Power Commission
1. Bureau of Power.

M. Veterans' Administration
1. Medical Research Division.

N. Treasury Department
1. Bureau of Engraving and Printing.
2. Bureau of the Mint.
3. Coast Guard.

O. Federal Loan Agency
1. Office of Rubber Reserve (RFC).

P. Tennessee Valley Authority
1. Operating Divisions.

Volume 4 entitled "Manpower for Research" emphasizes the fact that the relatively small number of scientists is the

[1] Does not reflect changes arising from the National Security Act of 1947 which established Departments of the Army, Navy, and Air Force.

limiting factor upon research expansion. In fact, after reading the whole report one is left with the impression that the proposed expansion was set as high as possible, consistent with the supply of scientists. Since colleges and universities are the primary sources of these trained personnel, this volume is of special interest to the administrators of institutions of higher education.

Volume 5 entitled "The Nations Medical Research" calls attention to how thin medical research has been in the past; to recent great advances growing out of the stimulus and support of war funds and to medical problems for the attention of medical researchers in the future.

Since this 1000 page report is literally filled with facts and figures, it seems impossible to make a detailed review. The discussion in this paper, therefore, will be limited to the major recommendations found in Volume 1 of the report.

Principal Recommendations

For a basis of discussion the eight principal recommendations of the report are quoted below:

1. That, as a Nation, we increase our annual expenditures for research and development as rapidly as we can expand facilities and increase trained manpower. By 1957 we should be devoting at least one per cent of our national income to research and development in the universities, industry, and the Government.
2. That heavier emphasis be placed upon basic research and upon medical research in our national research and development budget. Expenditures for basic research should be quadrupled and those for health and medical research tripled in the next decade, while total research and development expenditures should be doubled.
3. That the Federal Government support basic research in the universities and nonprofit research institutions at a progressively increasing rate, reaching an annual expenditure for at least $250 million by 1957.
4. That a National Science Foundation be established to make grants in support of basic research, with a Director appointed by and responsible to the President. The Director should be advised by a part-time board of eminent scientists and educators, half to be drawn from outside the Federal Government and half from within it.
5. That a Federal program of assistance to undergraduate and graduate students in the sciences be developed as an integral part of an over-all national scholarship and fellowship program.
6. That a program of Federal assistance to universities and colleges be developed in the matters of laboratory facilities and scientific equipment as an integral part of a general program of aid to education.
7. That a Federal Committee be established, composed of the directors of the principal Federal research establishments, to assist in the coordination and development of the Government's own research and development programs.
8. That every effort be made to assist in the reconstruction of European laboratories as a part of our program of aid to peace-loving countries. Such aid should be given on terms which require the maximum contributions toward the restoration of conditions of free international exchange of scientific knowledge.

Discussion of Recommendations

Recommendations 2, 3, 5 and 6 call for a 4 to 8-fold expansion of basic research within the colleges and universities themselves. Recommendations 1, 2, and 4 would require the colleges and universities to double the number of American scientists and research engineers, exclusive of university personnel by 1957. The roll of the colleges and universities during the next eight years is, therefore, twofold; first, to expand scientific activities and organization within the institution of higher learning 4 to 8 times, and second, during the same period double the total scientists in the United States.

Recommendation No. 1 is that we expand our research as fast as possible. No top restrictions are placed, but as a minimum performance it is estimated that by 1957 we should be spending at least 1 per cent of our national income which at that time is estimated at approximately two and one-half billion dollars. This is approximately eight times the total expenditure which was made for research in the United States in 1940. It is approximately twice as much as was spent in the year 1947. In 1940 there were between 80 and 90 thousand scientists and research engineers. It is estimated that in 1957 we can have as many as 270 thousand scientists and research engineers. The proposed minimum expenditures, therefore, are related to the number of men that can be supplied. As a matter of fact, the board which prepared the Steelman Report recognized that the manpower supply was the limiting factor to the whole expansion. The minimum expenditure recommendation, therefore, was probably based on the estimated possible supply of scientists and research engineers. The burden of doubling the number of scientists and research engineers in the next 8 years rests directly upon the colleges and universities in the country.

Recommendation No. 2 deals with distribution of the National Research and Development budget to the various types of research. For purposes of discussion the report classifies research into four categories: basic research, background research, applied research, and development. The intention of this classification is clear and it will not be necessary for the purpose of this paper to become involved in the arguments aroused by attempts to define the boundaries between these classifications. The important thing for the colleges and universities to note is that basic and background research has not received its just share of attention during the war period nor since. Applied research has not only used up much of the fundamental knowledge resulting from basic research but has exposed gaps in our basic research frontier. It is in the institutions of higher education where these gaps are to be closed.

Recommendation No. 3 would increase basic research funds from the government to universities and nonprofit institutions to 250 million by 1957. When this amount is added to the estimated basic research funds from other sources the total would be about 440 million in 1957. In 1947 the amount expended was about ¼ this figure or 110 million dollars. Since research is getting more and more expensive a budget four times as large would not mean four times the volume of research, but it may require four times as many scientists in the universities because the teaching load will increase simultaneously with the research load.

In many of the smaller land grant schools the principal research funds are those of the Agricultural Experiment Stations. The total research expenditure of the U.S.D.A. in 1947 was about 31 million which is roughly ⅛ of the proposed federal expenditure of 250 million for basic research in 1957.

A similar amount of 31 million came from the states as matching money, which means that in 1947 the research funds to the Agricultural Experiment Station was about ¼ of the federal money proposed for basic research in 1957. Now if the 250 million is distributed similarly to the Agrictultural Experiment Station funds, it would increase the federal research money to small institutions by four times and change the center of gravity of the work from Agriculture to basic science. This would call for reorganization of the research programs in these small institutions. How the money is finally distributed will have a profound effect upon all American institutions of higher learning. The report recommends that a National Science Foundation be created and that the responsibility of distribution be vested in this foundation.

National Science Foundation

Recommendation No. 4 is that a National Science Foundation be established.

According to the report the principal duty of this Foundation would be to distribute the federal grants for basic research. This is a much narrower function than was proposed by several of the National Science Foundations Bills considered by Congress. In spite of this restriction, the Foundation would still have a profound effect upon the development of our colleges and universities. The report emphasizes that a portion of the basic research funds should be used to strengthen the weaker but promising colleges and universities and thus increase our total scientific potential. There are clearly two points of view which might be taken in the distribution of funds by the N.S.F.: first, to give all the money to universities and organizations having strong research organizations in order to get the maximum immediate benefit, and second, to distribute the funds upon a geographic and population basis in order to better develop the long time scientific potential of the country. The path which will be followed will probably be between these two extremes. The N.S.F. will probably develop a relationship to the colleges and universities similar to the one which now exists between the Office of Experiment Stations of the U.S.D.A. and the Land Grant Colleges.

If the N.S.F. is independent of the Office of Experiment Stations (and this seems probable), each of the schools receiving funds from both sources could probably function best by having a dual type of research organization. One part would do the agricultural experimentation work as in the past and the new part would do the basic research work with money from the National Science Foundation.

If the foundation activity is limited to basic research, probably less than 10 per cent of the nations research program will come under their scrutiny. Under these conditions one may also expect extensive arguments as to whether or not research is basic or applied. And the definitions drawn will probably be affected by whether or not the agency concerned wishes to operate under the general jurisdiction of the National Science Foundation.

Recommendation No. 5 seems to be a corollary to recommendation 3. If all the potential scientists are to be trained, it seems certain that the economic barriers now preventing the college education of over half of our qualified young men and women will need to be removed. It is very difficult to see how these barriers can be removed for the potential scientists without, at the same time, removing the barriers for all other worthy students. This point of view is further emphasized and elaborated in the recent report prepared by the President's Commission on higher education. One ought not overlook the fact that if these barriers are removed, the teaching load in the universities will increase by over 100 per cent within the next decade.

Recommendation No. 6 is also a corollary to recommendation No. 3. If we attempt to carry this recommendation out on the scale proposed, we are likely to find difficulty in the procurement of the necessary items. It is quite likely that every institution of higher education which engages seriously in research will need to establish an instrument shop equipped with fine machines and manned by highly skilled workmen.

Recommendation No. 7 seems a little contrary to many statements found within the report. In many places throughout the report adequate coordination and cooperation between the government agencies is inferred. And yet, this recommendation No. 7 clearly indicates that the Presidential Research Board felt that better coordination and cooperation could be attained by the establishment of a federal committee. When one contemplates the size and complexity of government research, it is not surprising that such a committee is recommended.

The relationship between this committee and the National Science Foundation, as well as the relationship of the army, navy and air forces together with other federal agencies to the National Sci-

ence Foundation, is an important one. At this time most of the money for basic research as well as applied research is channeled through the military organizations. If the N.S.F. is to acquire its projected importance, it will have to become the principal source for federal money for basic research. A determined personnel for the N.S.F. and the help of Congress may be necessary if the N.S.F. is to become firmly established. The foundation's primary purpose is to guide and promote the nation's development in basic research and in order to do this it must control the purse strings to most of the basic research funds.

Recommendation No. 8 is a magnanimous gesture. It seems to recognize the unity of the world and if our prosperity is to be permanent, all nations of the earth must also prosper and benefit by advancing science. There is some difficulty encountered when attempts are made to define "peace-loving countries." Our definition of this term would likely depend upon our frame of reference. At the present time, no doubt, those countries joined with us in opposing Russian aggression would all be considered peace-loving countries. It is also quite likely that all countries affiliated with Russia would not be considered in this category. In spite of this, the Russians are still human and as individuals no doubt hope for peace. It may be that freedom-loving or non-aggressive countries would be more easily defined. At least, we may say that science prospers best in an environment of freedom and it would be a poor economic risk to put our money into dictator controlled science.

Since this is a meeting of engineering administrators, it may be appropriate to discuss the effects of the Steelman Report Recommendations which specifically effect engineering education. The report shows the scientific manpower pool of 1947 is 137,000 of which about 42,000 are research engineers, 30,000 chemists, 15,000 medical and health scientists, 15,000 other physical scientists, 12,000 agricultural scientists, 9000 other biologists, 8000 physicists and 6000 unclassified scientists. Of the 42,000 research engineers roughly ¼ are in colleges and universities, ½ in industry and ¼ in government employment. The engineering group is not only the largest of all, but shares with the chemist group the distinction of having adequate representation in each of the three following fields of endeavor: higher education, industries and federal organizations. Research engineers are not only distributed in all types of research organizations but also in all types of research from basic to development research. This group is the largest of all and can serve as a "cement" to bind together American research organizations as well as the different kinds of research. They can help to fill the large gap between purely basic research and the end application of basic research known as development.

For many years the engineering divisions of the Land Grant Colleges tried to establish a chain of experiment stations similar to the Agricultural Experiment Stations. These efforts were first defeated by the agricultural interests in the L.G.C. system itself. By the time this opposition was won over to support the movement, the American Association of Universities had grown strong enough to stop any legislation which applied only to the L. G. Colleges. The Engineering College Research Association then came into existence which tended to bring together the L.G.C. and A.A.U.

If this welding of the interests of the Land Grant College Association and the American Association of Universities can be completed and the gap between pure scientists and applied scientists bridged, the recommendations of the Steelman report can be accomplished.

Conclusion

The stage for organized university and college action seems to be set. These institutions and only these institutions seem to hold the keys to make possible the realization of objectives of the Steelman

Report. The need for research expansion is overwhelmingly recognized by our nation. All four of the important surveys mentioned in the first part of this paper strongly recommend the expansion of science, on on broad principles these four reports support each other. Most of the differences of opinion seem to revolve around the question, "who is to call the plays." It seems likely that if all institutions of higher learning could agree and jointly formulate a basic research policy of national scope, it would be accepted by the American people. The Steelman report emphasized the fact that applied research and development are now "scraping the bottom of the basic research barrel." It is hoped that the institutions of higher education will be able in the near future to effect a research program which will prevent the "barrel" from becoming bone dry.

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Summary of the Report of the Committee on Faculty Salaries

By WILLIAM C. WHITE, Chairman

Dean of Administration, Northeastern University

Introduction

In June 1948, Dean S. S. Steinberg, then serving as Vice President of A.S.E.E. in charge of the Engineering College Administrative Council, appointed a Committee on Faculty Salaries [1] to make a survey of the salaries currently paid to teachers in engineering schools and to compare these with the salaries paid to teachers in other professional schools and to engineers in non-teaching employment. This project had been suggested by Dr. D. C. Jackson as a result of his study [2] of engineering teaching salaries made under A.S.E.E. auspices in 1946–47. The following is a summary of the 70-page printed report issued by the Committee in June 1949 with funds generously provided by the Carnegie Corporation of New York.

During the summer of 1948 negotiations were carried on with officers of organizations similar to A.S.E.E. in other professional fields for the purpose of obtaining their cooperation in gathering the necessary data. Cordial responses indicating a willingness to participate were received from officers of the Association of Collegiate Schools of Architecture, the American Association of Collegiate Schools of Business, the American Association of Dental Schools, and the Association of American Law Schools. A persistent but unsuccessful effort was made to enlist the participation of the Association of American Medical Colleges.

By early fall of 1948 a questionnaire had been perfected by the Committee with the assistance of other representative engineering school administrators throughout the country. This basic instrument was subsequently adapted to the specific needs of other professional school groups and reprinted in slightly differing forms for distribution to all of their constituent institutions.

In addition to basic salary data, the Committee obtained information from professional schools with regard to extra payments for overload services during the academic year, for summer school teaching, and for the conduct of sponsored research both during the regular academic year and during summer periods. Institutional policies with respect to fundamental unsponsored research and with regard to consulting activities by staff members were also explored.

Questionnaires were sent to all institutions whose names were provided by the professional school organizations previously mentioned with the request that they be filled out and returned as soon as possible to the Secretary of the Committee.

In response to the original request and one or two follow-up letters appropriately spaced, usable replies were received as indicated in the following table. This gratifying response enhances the representative character of the data and indi-

[1] H. H. Armsby, C. L. Eckel, T. K. Glennan, T. Saville, M. G. Kispert, Secretary, W. C. White, Chairman.

[2] Report on Present Day Salaries of Members of Instruction Staffs of Engineering Schools in the U. S. and Canada, June 1947.

cates a widespread interest in the question of faculty salaries in professional schools.

Professional School Group	Number Mailed	Number Returned	Per Cent Returned
Engineering	154	123	80%
Architecture	50	43	86%
Business	58	54	93%
Law	103	93	90%
Dentistry	47	26	55%

Treatment of the Data

Since this salary survey was conceived as a comparative study, it was obviously necessary to decide upon some unit as a common denominator. A preliminary analysis of returned questionnaires indicated that the plans under which teachers are paid vary considerably among institutions and that it would be necessary to adopt some arbitrary basis for comparisons. Slightly more than a third of the engineering schools reporting (45 out of 123) pay their teaching staffs wholly or partly for 12 months' service with from 4 to 6 weeks' vacation. About 19% of the teachers reported fall in this classification. The remaining engineering schools (78 out of 123) base annual salaries upon the academic year of 9 or 10 months, leaving the staff free during the summer to accept other employment.

In view of this situation, the Committee decided to use an academic year of 10 months, including 4 to 6 weeks' vacation, as the standard base upon which to report all teaching salaries in the professional schools. Since teachers on 12-month contracts are called upon for service during 6/5 of the standard work year that was adopted in this report for comparative purposes, their salaries were uniformly reduced by 1/6 in compiling the data.

This procedure differs from that of the Jackson report two years ago, but it appears to represent more nearly the mean among institutional practices as revealed in the summer term data available to this Committee. Dr. Jackson did not have comparable data. He reduced 12-month salaries on a sliding scale as follows: department heads—0, professors and associate professors—1/5, assistant professors and instructors—1/4. These changes in computing procedure will tend to show increases in salaries of department heads over those reported by Dr. Jackson which

TABLE II

COMPARATIVE DATA ON BASE MONTHLY SALARY RATES OF ENGINEERING TEACHERS AND PROFESSIONAL ENGINEERS IN NON-TEACHING EMPLOYMENT AT FOUR LEVELS OF EXPERIENCE

Experience Level in years assumed for the several academic ranks	*A Highest Monthly Salary of lower 25% Prof. Engr. as rpt'd by EJC—1946	B Data in Col. A inc. by 20%	**C Highest Monthly Salary of lower 25% of Eng. Tchrs. 1948–49	*D Median Monthly Salary of Prof. Engs. as rpt'd by EJC—1946	E Data in Col. D inc. by 20%	**F Median Monthly Salary of Eng. Tchrs. in 1948–49	*G Lowest Monthly Salary of upper 25% Prof. Engrs. as rpt'd by EJC—1946	H Data in Col. G inc. by 20%	**I Lowest Monthly Salary of upper 25% of Eng. Tchrs. 1948–49
25–29 (Profs.)	395	474	500	511	612	580	716	859	670
20–24 (Assoc. Profs.)	409	491	410	481	577	440	623	748	500
12–14 (Asst. Profs.)	354	425	350	385	462	380	521	625	420
7–8 (Instructors)	311	373	290	360	432	300	423	508	320

* Table 1.2a, page 8, "The Engineering Profession in Transition."

** One-tenth of annual salary on a ten-month base. Only about 57% of the teaching staffs receive the equivalent of twelve such payments from their institutions.

are somewhat less than have actually occurred; but increases in salaries of other academic ranks will appear to be greater than have actually taken place. This comment applies only to that 19% of the salaries reported by institutions on a 12-month basis.

Another factor which should be borne in mind in making certain comparisons with the Jackson report is that he used *medians of average* salaries, whereas this Committee reports *medians of median* salaries. The latter measure of central tendency was chosen because it is less affected by extreme values and because it permits better comparisons with engineering salaries contained in the E.J.C. Report on "The Engineering Profession in Transition."[3]

In its full Report—copies of which may be obtained from A. B. Bronwell, Secretary of A.S.E.E.—the Committee has presented basic salary data for engineering schools in 1948–49 following the same general pattern worked out by Dr. Jackson under which the material is classified both by geographical regions and by types of institutions.

Because of the smaller number of institutions involved and the fact that classification by region and by type of institution would not be particularly meaningful, the Committee tabulated the data from schools of architecture, business, dentistry, and law for the country as a whole. In all other respects the salaries of teachers in these professional schools were analyzed in the same way as those of teaching staffs in schools of engineering—using a ten-month academic year inclusive of 4 to 6 weeks' vacation as a base, and reducing all salaries reported on a 12-month plan by 1/6.

Mindful of its assignment to conduct a comparative study, the Committee sought to tabulate basic salaries in such a way as to reveal the maximum of useful information without identifying any institution with a specific set of data. Accordingly in the tabulations each institution is indicated by a code number with the maximum, minimum, and median salary which it reported for each academic rank. The data are arrayed in descending order of magnitude of the maximum salaries reported, each horizontal line representing the data from a single institution.

Beside every tabular view of salaries in each academic category is a summary which shows:

1. the number of institutions reporting
   the number of teachers reported
2. how many teachers at how many institutions are paid for 12 months of service
3. the median of maximum salaries reported by institutions
   the median of minimum salaries reported by institutions
   the median of median salaries reported by institutions
4. the individual maximum salary reported
   the individual minimum salary reported
   the individual median salary reported

In making comparisons with data from Dr. Jackson's 1947 report, the institutional medians listed under 3 above may be useful if the differences in procedure previously mentioned are borne in mind. The individual medians were calculated on the assumption that data reported were reasonably evenly distributed throughout the range and are of course only close approximations. When compared with the institutional medians they indicate whether the preponderance of teachers are serving at the higher paying or lower paying institutions and they may be compared with medians of engineering salaries in non-teaching employment.

Comparisons of Salaries in Professional Schools

In this summary space does not permit reproducing the detailed tabulations in

[3] "The Engineering Profession in Transition," Engineers Joint Council, 1947, Andrew Fraser.

TABLE III

RANGE BETWEEN MAXIMUM AND MINIMUM SALARIES* WITH CALCULATED MEDIANS** FOR TEACHERS IN VARIOUS RANKS IN FIVE TYPES OF PROFESSIONAL SCHOOLS IN 1948-49

Schools	Professors (Including Dept. Heads)				Associate Professors				Assistant Professors				Instructors			
	Maximum	Minimum	Range	Ind. Median	Maximum	Minimum	Range	Ind. Median	Maximum	Minimum	Range	Ind. Median	Maximum	Minimum	Range	Ind. Median
Architecture	12000	3000	9000	5800	8000	3600	4400	4600	8000	2800	5200	3800	4000	2000	2000	3200
Business	14000	3800	10200	6500	9500	3500	6000	5000	7000	3000	4000	4000	5400	1900	3500	3100
Dentistry	10800	3000	7800	6600	7300	3800	3500	5300	6300	2500	3800	4300	5400	1000	4400	3100
Engineering	12000	3700	8300	5800	9500	3000	6500	4400	6800	2500	4300	3800	4700	1700	3000	3000
Law	15000	3500	11500	7100	8000	3600	4400	5000	7000	2500	4500	4200	7500	2400	5100	3600

* Based on 10 months of service; salaries reported for more than 10 months of service have been reduced by 1/6.

** These are the individual medians for the country as a whole, calculated from the data reported by taking into account the number of teachers at each institution.

the Report for individual institutions. Comparative information as to the relationships among salaries in the various professional schools is given in Table III which shows individual maximum, minimum, and median salaries among all the teachers reported in the several fields represented in the study.

There is a very wide range in the salaries paid to teachers in each of the five professional school groups in all academic ranks as shown in Table III. Reasonable differences in teachers' salaries for a given rank because of ability, experience, location of the school, institutional standards, and other factors are to be expected. But the salary ranges shown in Table III seem to be excessively broad especially since the great majority of the institutions represented are offering accredited curricula. Teachers in the higher paying institutions command substantial salaries; staff members at institutions whose salary schedules are at the lower end of the range do not appear to be adequately paid for the kind of service they ought to render. It is of course inevitable that the effectiveness of instruction will vary from institution to institution and salary alone is not a fair index of instructional efficiency, but if the quality of the work carried on in professional schools varies on a scale at all proportional to that of the salaries paid to members of teaching staffs the situation is not sound.

Examination of the tabulated data in Parts Three, Four, and Five of the complete Report should enable each institution to find its own position as to salaries in the educational scene and thus to judge whether its salary scale is a reasonable one. Local economic conditions, opportunities for teachers to supplement their incomes through professional practice, summer teaching or research, the quality and amount of service that members of the staff are expected to give, and the financial status of the institution—all these are additional factors that need to be taken into account when the adequacy of salaries at a particular institution is being considered.

Table IV shows the relative over-all status of teachers in the five types of professional schools studied. In comparison with salaries paid to teachers in other professional schools, salaries of engineering teaching staffs at the median level are at the bottom of the range in all ranks except that of department head. Salaries of teachers in architec-

TABLE IV

COMPARISON OF ANNUAL SALARIES OF FACULTY MEMBERS IN PROFESSIONAL SCHOOLS
Maximum, Minimum, and Median Salaries Reported by Institutions for 1948–1949

(All data are on a 10-month basis; 12-month salaries have been reduced by 1/6)

						Medians of Maxima					Medians of Minima					Medians of Media				
Professional Schools	No. of Institutions Rpt'g	No. of Teachers Rpt'd	Percentage of Tchrs. Paid 12 months' serv. whose Sal. 20% higher than here shown	% Tchrs. whose '48 Summer Service Augmented Inst Sal. by about 20%	Total % Tchrs. whose 12 mo. Inst. Sal., '48 9 were about 20% higher than here shown	Department Head	Prof. (including dept. hds.)	Associate Professor	Assistant Professor	Instructor	Department Head	Prof. (including dept. hds.)	Associate Professor	Assistant Professor	Instructor	Department Head	Prof. (including dept. hds.)	Associate Professor	Assistant Professor	Instructor
Archit.	43	516	12%	36%	48%	6400	6000	4800	4000	3400	6300	5000	4300	3600	2850	6400	5300	4500	3850	3050
Bus.	54	2252	9%	43%	52%	6000	6500	5000	4300	3500	5300	4950	4400	3500	2800	5600	5800	4750	4000	3100
Dent.	26	388	74%	2%	76%	6900	6800	5650	4800	3800	5000	5400	4600	3800	2800	6250	6200	5350	4400	3300
Eng'g	123	8541	19%	38%	57%	6200	6300	4800	4000	3500	5000	4800	4000	3300	2700	5700	5200	4300	3700	3000
Law	93	813	11%	44%	55%	7050	6450	5200	4400	3600	7050	5500	5000	4000	3500	7050	6050	5150	4200	3600

ture are only slightly higher, then come salaries of business school staffs, with the salaries in law schools and schools of dentistry at the top. These two last mentioned schools are definitely at the graduate level whereas the first three are generally concerned with both undergraduate and graduate work. If a comparison were possible between the graduate instructional staffs in engineering schools and the instructional staffs in schools of law and dentistry, it is our belief that the respective salaries would be more nearly of the same magnitude.

The differences in medians of maxima reported by the five types of professional schools are much less pronounced but the salaries of teachers in dental schools and law schools are still at the top of the range. At median of minimum levels, salary scales for engineering teachers are again somewhat lower than those for staff members in other professional schools. On the other hand the percentage of engineering teachers whose salaries are actually 20% higher than tabulated because of service to their institutions during the summer is 57%, which is higher than that of any of the other professional groups except teachers of dentistry where the percentage is 76%.

Individual medians in every academic rank except that of professor on a country-wide basis are very close to the institutional medians. For professors, in all of the professional school groups studied, the individual medians range from $400 to $1050 above the institutional medians ($500 in Schools of Architecture, $700 in Schools of Business, $400 in Schools of Dentistry, $600 in Schools of Engineering, and $1050 in Schools of Law), presumably indicating that the preponderance of teachers in this rank are employed by the higher paying institutions.

Although accurate comparisons are not possible for reasons previously stated, it appears that the salaries of engineering teachers have generally increased in the two-year period since the Jackson Report: roughly 10% on the whole—slightly more than this for instructors, slightly less for assistant professors—and with considerable variation percentagewise among the institutions reporting. In fact the spread in salaries of engineering teachers among institutions, the variety of factors related to their compensation such as privileges of graduate study, extra pay for evening teaching, opportunity for research activity and consulting practice, type of environment, geographical location, housing conditions, prospects for advancement, and similar matters make it difficult to generalize in a meaningful way upon the inadequacy or adequacy of the situation as a whole.

Comparison of Salaries of Teachers in Engineering Schools with Salaries of Engineers in Non-Teaching Employment

The most difficult part of the Committee's assignment was that of comparing salaries paid to teaching staffs in engineering schools with those of engineers in non-teaching professional employment. With the resources at its command, the Committee could obtain reliable data regarding 1948–49 teaching salaries directly from engineering schools, but to collect comparable current information with respect to salaries of non-teaching engineers was not feasible.

Mindful of the comprehensive and authoritative study of salaries paid to professional engineers prepared by Mr. Andrew Fraser as part of the 1946 Survey of the Engineering Profession sponsored by Engineers' Joint Council, the Committee decided to utilize the basic data of that report as initial reference points, and to try to find out what had happened to the salaries of engineers in industry since the autumn of 1946 with a view to applying appropriate correction factors.

Such a procedure was obviously not ideal, but since no more promising and yet practical alternative presented itself, the Committee felt that this plan should be tried. Accordingly a letter was sent early in January, 1949, to about 200 companies, located throughout the United States and employing large numbers of engineers, with the request that they indicate the percentage increase in salary that had occurred between August, 1946, and the end of 1948 for:

(a) newcomers to the profession
(b) engineers with 5 to 6 years' experience
(c) engineers with 12 to 15 years' experience
(d) engineers with 25 to 30 years' experience
(e) engineers with more than 30 years' experience

The eighty-six replies that were received came from all sections of the country and are estimated to represent several thousand engineers because the respondents were mostly large industrial corporations. A tabulation of these replies shows that the median increase of salaries during this period was 20% in all five categories. It is interesting to note that the cost of living as reflected in the Consumer Price Index for Moderate Income Families in Large Cities compiled by the U. S. Bureau of Labor Statistics increased by approximately this same percentage over the two-year period ending in September, 1948, although it has since dropped a few points.

The Committee is cognizant of the prevailing impression that the salaries of younger men have increased percentagewise more than those of the mature engineers and realizes that a more comprehensive survey might show this to be true. The present survey shows that about half of the 44 companies who submitted complete replies think that they have increased salaries all along the line by about the same percentage and that the other half believe that they have increased the salaries of their more experienced engineering personnel somewhat less than the salaries of younger ones.

Moreover the available information on increases in engineering salaries in industry is based on a rather small sample. It is also true that while practically all who replied answered the questions with respect to the first three categories, only about half furnished information about the last two which pertained to engineers of long standing. Many respondents said they found it very difficult to differentiate at the upper experience levels between general salary increases attributable to the economic situation and merit increases based upon individual achievement. In addition it is likely that the estimates of the percentage increases in the more experienced groups may be unconsciously biased upward because people tend to think in terms of absolute rather than relative changes.

For these reasons the Committee doubts the validity of the median increase in salaries of 20% at all five experience levels during the two year period beginning in the fall of 1946. The increase of 20% for men ten years out of college is confirmed by the April, 1949, report of the General Survey Committee of the Engineers' Joint Council. It seems likely, therefore, that this figure is a reasonably sound approximation for the upward trend of salaries paid to younger engineers, but it is to be doubted that the salaries of the more experienced engineers have increased percentagewise by that amount, although they have unquestionably increased somewhat.

Comparison with E. J. C. Survey

The problem of comparing current teaching salaries in engineering schools with salaries paid to engineers as reported in the E. J. C. Survey of 1946 is complicated not only by the difficulty of determining a suitable percentage of upward correction for data at each experi-

ence level, but also by a number of other factors such as the following:

(1) Teaching salaries are reported on a ten-month basis inclusive of four to six weeks' vacation; whereas salaries of non-teaching engineers are generally paid on a twelve-month basis with from two to three weeks' vacation.

(2) Teaching salaries are reported in terms of academic rank, whereas E. J. C. data are tabulated in terms of years of experience.

(3) The data on teaching salaries were reported by institutions and are presumably representative of teaching staffs as a whole. The data compiled by E. J. C. were obtained from information voluntarily supplied by individual members of six national professional societies, and although there were some 47,000 returns, there is the possibility that these may have come in greater numbers from the more successful segment of the engineering profession than from the less well paid practitioners. And finally, the information as to increases in salaries since 1946 comprises company estimates and not factual data submitted by individuals.

Tabulation as a Rough Comparison

With all of these obstacles to direct comparison, the Committee obviously could not prepare any meaningful and valid graph showing relationships between the salaries of engineering teaching staffs and those of engineers in non-teaching employment. There remained the possibility of tabulating available data which, although not susceptible to direct comparison, would show in a very general way the relative salary status of engineering teachers and engineering practitioners.

Table II is an attempt to do this. In it the monthly salary rates at the 25th, 50th, and 75th percentiles of professional engineers at four experience levels are reproduced directly from Table 1.2a on page 8 of the "Engineering Profession in Transition." These original data from the E. J. C. Report appear in Table II as columns A, D, and G. Adjacent to these figures in columns B, E, and H are the same data increased by 20% in all cases. This is a purely arbitrary tabulation for purposes of discussion because, as has been already pointed out, the Committee does not feel warranted in drawing reliable conclusions from its limited study of recent trends in salaries paid to engineers in industry.

Columns C, F, and I show monthly salary rates at the 25th, 50th, and 75th percentiles of teachers in engineering schools in the four usual academic ranks. These percentiles were calculated from the median salaries reported for the country as a whole, taking into account the number of teachers reported by each institution. Annual salaries were divided by 10 in all cases to arrive at the monthly salaries shown in these columns.

Although the data on teaching salaries are believed to be reliable *in terms of academic rank,* they are of course not directly applicable to the experience levels with which they have been identified in Table II. In order to make a truly valid comparison between salaries of teachers and practitioners one would need data from the engineering colleges in which salaries were reported by age level rather than by academic rank.

Not having such data, the Committee tried to make a rough approximation that might be helpful in thinking about relative rates of pay for teachers and practitioners. The average ages of faculty members in each of the four academic ranks in the six institutions represented by members of the Committee (Case Institute of Technology, University of Colorado, University of Maryland, Massachusetts Institute of Technology, New York University, and Northeastern University) were found to be very nearly the same and therefore assumed to be typical of the general situation. There

seemed to be no point in making a more elaborate study of this matter since the only purpose to be served was to arrive at some reasonable approximation that would enable rough overall comparisons to be made.

For the six institutions, average ages of staff members in the several ranks were found to be as follows: professors—49 years, associate professors—44 years, assistant professors—36 years, and instructors—30 years. Since the median age for entering the profession of engineering was reported by E. J. C. to be 23 years, the experience level for each academic rank was determined by subtracting this age from the average ages of teachers stated above. In this way it is possible to effect an approximate relationship between the E. J. C. data and the monthly salaries of engineering teaching staffs.

It should be borne in mind that only about three-fifths of the engineering teachers are paid for 12 months' service to their institutions. The remainder are paid for an academic year of nine or ten months, although many of these undoubtedly supplement their incomes through summer employment for which the institutions assume no responsibility.

After making due allowance for the inadequacies of the data, which have been previously pointed out, the Committee believes the evidence indicates that monthly salaries of teachers in engineering schools are, on the whole, somewhat below those paid to engineers of comparable experience in non-teaching employment. It is true, however, that many engineering teachers have opportunities to supplement their annual income in ways that are not available to engineers in non-teaching employment.

Except for professors at the median and lower 25% levels the salaries of engineering teachers lag behind or at least have not passed beyond the rates reported two years ago by E. J. C. for professional engineers of roughly comparable experience. How much the salaries of engineers in non-teaching employment have increased since the fall of 1946 at various experience levels is open to question, but it is generally known that there have been increases all along the line.

At present teaching salaries compare least favorably with salaries of engineers in general at the instructor level. The nearest approaches to parity with the salaries paid to engineers in non-teaching employment occur at the level of full professor.

College Notes

California Institute of Technology announces the appointment of two new members to its Engineering Division. Dr. Jack E. McKee, who has been associated with the firm of Camp, Dresser, and McKee, sanitary engineers of Boston, Massachusetts, will come to the Institute as Associate Professor of Sanitary Engineering and Caleb W. McCormick, formerly with C. F. Braun & Company and Dames & Moore, soil mechanics and foundation engineers, will come as Instructor in Civil Engineering.

Robert L. Shurter has been appointed the first director of a newly created division of social-humanistic studies at **Case Institute of Technology.** The new division has been created to direct the interdepartmental cultural courses introduced in Case's new curriculum. Dr. Shurter has been professor of English and head of the department of language and literature since 1946. He has been on the Case faculty since 1930.

Report of the Committee on Selection and Guidance

By O. W. ESHBACH, *Chairman*
Dean of Engineering, Northwestern University

It is now eight years since President Cullimore, retiring chairman of the Committee on Orientation of Freshmen of the Society for the Promotion of Engineering Education, wrote to his successor, Dean R. L. Sackett, who was also chairman of the Committee on Student Selection and Guidance of the Engineers' Council for Professional Development, proposing that under Dean Sackett's chairmanship the two societies combine their efforts to give professional and sustained effort to the solution of their mutual problem of reducing student eliminations from college by better selection and early and better guidance.

Your Committee feels that it is appropriate, because of change of sponsorship during the last year, to review briefly the origin of the Measurement and Guidance Project, its experience during four years of War, the four years following the War, its present status, and to draw tentative conclusions and make recommendations for future progress.

Origin

Prior to President Cullimore's suggestion, both the SPEE and the ECPD had made considerable progress in the appraisal of their own philosophies, methods and goals. Engineering educators had long recognized the chronic problem of assisting high school teachers and students to give better guidance to those presumably interested, and particularly to those qualified to study engineering.

Among the colleges many had been active in schemes for freshman guidance. Dean Sackett and President Cullimore were particularly impressed by the work of Dr. A. B. Crawford at Yale, who, at the time, had summarized his experience in a book entitled "Predicting College Achievement." After several conferences with him, Dr. Crawford suggested that Dr. Russell S. Bartlett be retained to extend and test the studies already begun. This work could be described as an attempt to determine the mental differences between arts, science, and engineering students enrolled in the common freshman year at Yale. Arrangements were made to give a battery of tests to arts and engineering freshmen at the opening of school in the fall of 1941. The following schools participated:

The Universities of Florida, Missouri, Tennessee, Texas
Northwestern University
Newark College of Engineering
Pasadena Junior College

In the initial trial a set of six tests was administered to about 1800 entering freshmen in arts and engineering, and a modified battery of tests of the same general content were given to about 1000 high school juniors residing in or near Newark. The six tests, listed by name, were as follows:

I. Verbal Comprehension
II. Artificial Language
III. Quantitative Reasoning
IV. Spatial Visualizing Ability
V. Mathematical Aptitude
VI. Mechanical Ingenuity

The tests and progress records for the students were assembled and carefully checked. Students who withdrew during

[1] Presented at the General Session at the Annual Meeting of the ASEE, Troy, N. Y., June 22, 1949.

the freshman year, or whose records were incomplete, were eliminated from the study, with the result that complete records were available for 979 students. A report on the study was printed in the JOURNAL OF ENGINEERING EDUCATION, Vol. 34, April, 1944. Without going into the details of results, it is significant to note that the intercorrelation between the last four tests was quite high, varying from .536 to .686. Only two of the tests, Quantitative Reasoning, and Mathematical Aptitude, showed a correlation above .500 with freshman grade averages. The most predictive tests of success in the cultural aspects of the engineering curriculum were Test I, Verbal Comprehension, and Test III, Quantitative Reasoning, with validity efficients of .40 and .43, respectively.

The Committee originally planned to administer objective achievement examinations at the end of the freshman and sophomore years for purposes of correlation between grade-point averages and the original tests. As this work was about to be initiated, Dr. Bartlett resigned to accept a position as Headmaster of the Gunnery School and plans had to be changed.

At this time the War was beginning to exert influence upon engineering education, which re-focused the attention of educators on the problems of student selection and curricular organization.

The Carnegie Foundation for the Advancement of Teaching was acquainted with the work of the ECPD and the SPEE and had also organized a Graduate Record Office to study collegiate and graduate education. Through the interest of President Robert E. Doherty of ECPD, the Foundation became interested in sponsoring the continuation of the experiment begun by Dean Sackett and President Cullimore. The project was known as the Measurement and Guidance Project, sponsored jointly by the ECPD, the SPEE, and the Carnegie Foundation. The work centered in the Foundation's Graduate Record Office.

Organization and War Experience

The agencies jointly sponsoring the measurement and guidance project agreed on the formation of three committees: (1) an advisory council, (2) a consultant committee, and (3) a measurement committee, to cooperate wherever possible with the committees of SPEE and ECPD, whose activities were related. The general aims were to develop a series of predictive tests; to determine the validity of these tests in predicting success, particularly in the freshman year; to develop achievement examinations in subjects characteristic of engineering curricula; and to validate these achievement examinations.

It was realized that the study was being undertaken at a hazardous time. Problems of selection were not normal. Thousands of students were enrolled in the ASTP and the V-12 programs. Few of the civilian students were permitted to continue their education beyond their freshman and sophomore years.

Nevertheless, with the cooperation of these institutions,

California Institute of Technology
Carnegie Institute of Technology
State University of Iowa
Massachusetts Institute of Technology
University of Michigan
Newark College of Engineering
North Carolina State College of Agriculture and Engineering
Northwestern University
Rose Polytechnic Institute
University of Tennessee
University of Texas

and under the direction of Dr. K. W. Vaughn, of the Carnegie Foundation, the project was launched and the present tests known as the "Pre-Engineering Inventory—Revised Form A" were developed. The type of test, and the time to administer each of them is as follows:

		Minutes
Information Blanks and Interest-Hobby Questionnaire		20
Test I.	General Verbal Ability	35
Test II.	Technical Verbal Ability	25
Test III.	Ability to Comprehend Scientific Materials	90
Test IV.	Ability to do Quantitative Thinking	70
Test V.	Ability to Comprehend Mechanical Principles	40
Test VI.	Spatial Visualizing Ability	30
Test VII.	Ability to Comprehend Social Science Materials	40

They were first used in the fall of 1943 and revised in the summer of 1944. A summary of the number of tests conducted was reported by Dr. Vaughn in the JOURNAL OF ENGINEERING EDUCATION, Vol. 39, June 1946. The number of participating institutions and tests given in each of the three years, ending with the close of the War, are as follows:

NUMBER OF PARTICIPATING COLLEGES AND STUDENTS TESTED

	1943–1944	1944–1945	1945–1946
Number of Institutions	9	29	32
Number of Students	1703	6208	12,307

Measurement and Guidance Project

In addition to this number, 15,000 other students took all or part of the Pre-Engineering Inventory Tests. These students were tested under varying circumstances, mainly in connection with the armed services training programs, and were not classified as regular freshman engineering students. It must be recognized that, up until the close of the war, no satisfactory opportunity, due to lack of educational continuity, was presented to make proper studies of the validity of the tests, which was one of the basic objectives. The experience did provide opportunity to test a total of about 35,000 students under controlled conditions.

Post-War Program

During the first year after the War, under the direction of Dr. Vaughn, plans were made to establish norms for the engineering inventory tests and also to improve methods of reporting. Simultaneously, sophomore achievement tests were developed and experimental forms made available for the following year. Tests for senior engineers, and a high school series of guidance tests, were also proposed.

It should be emphasized that the summer and fall of 1946 provided an unusual, and probably the first, opportunity of carrying through a program of appraisal. Obviously it was the first time that any assurance could be had for the normal education of engineering students. The Project took advantage of this opportunity by making a special analysis of the examinations of 9994 freshmen who were tested during the summer and fall of 1946, and issued in May of 1947 what is known as the "Norms Bulletin." The features of this Bulletin included the establishment of a scaled scoring system, the selection of standard samples, and the segregation of private and public colleges, veterans and non-veterans, and those with previous college training from those who entered as normal freshmen. The standardization group on which the scaled score system was based included 7187 freshman engineering students, none of whom had been previously enrolled in college. The majority of these students, in the ratio of five to two, were accepted by public colleges; likewise, the majority in approximately the same ratio were veterans.

During the year thirty-nine engineering schools participated in the testing program. The number of students tested was 32,098, involving 627 testings, as indicated in the table below:

NUMBER OF STUDENTS TESTED IN 1946–1947

Group		Number of Testings	Number of Students
A	PEI Institutional Testing (38 colleges)	87	20,786
B	PEI National Testing	429	2,732
C	PEI Special Testing	100	2,041
D	Achievement Testing—Sophomore	7	2,180
E	Achievement Testing—Experimental	4	4,359
		627	32,098

This year also marked the inauguration of the sophomore achievement tests with the participation of seven institutions. Among the purposes of the latter program was the study of the validity of the Pre-Engineering Inventory Tests by obtaining correlations between the tests, grade-point averages, and PEI scores. To date, insufficient data are available to draw any conclusions. The Project really has not had time to have a fair chance.

The first results, published in the spring of 1947, gave the following correlation scores on the several PEI tests with grade-point averages during the first semester of study in ten colleges of engineering:

Testing Service. Later in the year Dr. Vaughn severed his connections with the Carnegie Foundation.

After considerable discussion and investigation, the ECPD and the ASEE entered into an arrangement with the Educational Testing Service so that the Measurement and Guidance Project might be carried on. Thus, during the recent year, the Educational Testing Service has administered the Pre-Engineering Inventory Tests and assumed financial responsibility for the Project. Both the ASEE and the ECPD are represented on an advisory committee to the Testing Service. This committee is composed of representatives of the three bodies involved.

It should be appreciated that the transfer of the Project to a new agency, however experienced in testing methods, involved a number of difficult problems which could neither be quickly nor easily resolved. The first of these involved an analysis and projection of the costs, in which it appeared that the Project could not be self-supporting. While this problem was being studied, the Educational Testing Service proceeded with the administration of the Pre-Engineering Inventory tests as heretofore and established a program of national administration. This provided for giving the tests at approximately 160 centers in forty-seven states. A bulletin of information was prepared and distributed to the colleges and high schools establishing the dates of March 5 and June 25, 1949, for the administering of the tests. It was contemplated that the Pre-Engineering Inventory would be given to the fresh-

		Range	Median
Test I.	General Verbal Ability	.16–.50	.38
Test II.	Technical Verbal Ability	.25–.55	.47
Test III.	Comprehension of Scientific Materials	.41–.65	.55
Test IV.	General Mathematical Ability	.51–.71	.62
Test V.	Comprehension of Mechanical Principles	.30–.55	.39
Test VI.	Spatial Visualizing Ability	.22–.42	.35
Test VII.	Understanding of Modern Society	.25–.53	.41
Composite Score		.44–.68	.62

In the fall of 1947 the number of participating institutions increased to fifty and the post-War development program continued as previously organized until 1948. At that time the Carnegie Foundation withdrew from all testing activities, and the Project, together with the College Entrance Examination Board and certain professional groups, entered into an arrangement with a newly-formed agency called the Educational

man classes at those institutions which wished to use them for guidance and experimental purposes. It was estimated that a charge of $2.00 a student would be needed to cover costs and that the institution would either pay the cost itself or transfer it to the students. The national testing service, at established centers, would make available pre-admission examinations for the institutions who wished to use the tests for this purpose. The cost was set at $7.00 a student, to be borne by the student.

During the first year under the new sponsorship, the Project continued the program as projected in the preceding year. The number of tests administered during 1947–1948 and 1948–1949 were as follows:

	Number Tested	
	1947-1948	1948-1949
1. Pre-Engineering Inventory Institutional Enrollees	11,267	8,889
2. Pre-Engineering Inventory Institutional Applicants	4,643	
3. Pre-Engineering Inventory National Program (and State Program) Applicants	4,252	3,793
4. Pre-Engineering Inventory Special Programs (probably applicants)	406	91
5. U. S. Merchant Marine Cadet Corps Testings	1,539	1,573
6. Engineering Achievement Tests	7,105	2,583
Grand Total	29,212	16,929

In addition, the number of schools participating in the Achievement Tests increased to seventeen. Validation studies were also continued and a report made to the Advisory Council and the ECPD.

While every attempt has been made to carry on the Project as originally planned, grave concern has been expressed by members of the Advisory Committee and by institutional representatives as to the practicability and financial success of the tentative proposals. This situation was immediately anticipated by your Committee, but no information from experience was available. It appears that a projection of income and expense for the current year, even at increased rates, would cause the Project to operate at a deficit which is prohibitive.

Although no satisfactory solution is apparent, in anticipation of continued conferences, your Committee obtained the opinion of the participating institutions as to their intention of continuing the Project, the degree to which they would use the examinations if available for entrance purposes, and the extent to which they were able to appraise their value. On the basis of replies received, your Committee believes that institutions will cooperate as they have in the past to achieve the purpose of establishing adequate tests for guidance of freshmen, reliable tests for admission purposes, achievement tests at the sophomore and senior levels, and guidance tests for high school juniors. It is recognized that this must be done in a practical way at justifiable costs, with full appreciation that quick results may not be obtained. While the administrative problems in the immediate future have not been clarified, certain conclusions and recommendations are presented.

Conclusions and Recommendations

Most of the Pre-Engineering Inventory Tests are given after admission and administered by the cooperating schools, the object being to use them for guidance purposes, check their admissions against national norms, and help to establish the validity of the tests for predicting success in college.

Only a few of the colleges use the tests for the selection of freshmen. This is to be expected, because most of the state institutions are required to admit students on high school certificate. For this reason it may be anticipated that the national testing centers program will not be used sufficiently to support the program financially.

The best predictive single test is the mathematics test (IV). The composite score which is the sum of the scores of Tests II, III and IV shows promise of simplifying the tests, reducing the number, and the time of administration.

Many of the private schools feel that high school grades, combined with tests administered by their own admissions offices, produce satisfactory results for admission purpose.

If the program is to continue and succeed, which will require many years of experimentation, it must be done on a sound financial basis with ample funds for research. This means wider participation and simplification of tests.

Your Committee asks for the continued cooperation and support of the Measurement and Guidance Project by the engineering schools, and makes the following recommendations to the ECPD Committee on Student Selection and Guidance and the Advisory Committee of the Educational Testing Services:

1. Make the present battery of Pre-Engineering Inventory Tests available without scoring service at $1.00 per student, and with scoring service at $2.00 per student.
2. Terminate the National Testing Center service and arrange with the College Entrance Board for an additional optional test so as to cover essentially the present P.E.I. Tests.
3. Continue the development of sophomore achievement tests and make them available on the same basis as P.E.I. to participating institutions with and without scoring service.
4. Consider future development of senior achievement tests in the several professional fields of Engineering.
5. Continue validations tests and periodically establish national norms.
6. Encourage the development of Aptitude, Interest and Personality Tests for Guidance at high school level.

Discussion

Dr. Chauncey (Educational Testing Service): Mr. Chairman, Members of the A.S.E.E.: I am delighted to have the opportunity to meet with you and talk briefly with you today, even though I learned I was to do so only ten minutes ago. I am particularly glad because there are some problems concerned with the Measurement and Guidance Project in Engineering Education which I would like to talk over with you.

A year-and-a-half ago, when we took over the administration of the tests under the program of the Measurement and Guidance Project we did so with a great deal of enthusiasm because we felt that a good start had been made and that there was a great opportunity for developing tests that would be very useful to engineering schools—tests for selection of students, tests for the guidance and placement of students, and tests to measure the achievement of students.

We immediately undertook to establish a contractual and working relationship with the A.S.E.E. and the E.C.P.D. That took a little time because of the usual difficulties of tripartite relationships. But it was accomplished about a year ago. Advisory committees were set up and we have met, from time to time, both with the Selection and Guidance Committee of A.S.E.E. and with the special Advisory Committee representing both societies and E.T.S.

First we tackled procedures for the administration of the Pre-Engineering Inventory and we feel that we have improved them. More important, we conducted studies that had been neglected previously. We made reliability studies of both the Pre-Engineering Inventory and Engineering Achievement Tests. We made analyses of the relationship between the total score and the part scores; we made item analysis studies which would lead to the development of new forms of the Pre-Engineering Inventory, both analyses against scores on the tests themselves and also item analyses against out-

side criteria—against grades in engineering schools—which are particularly helpful in making a strong, valid test.

We also made validity studies at twelve of the engineering schools. And I am glad to report that these studies, in general, show that the Pre-Engineering Inventory is doing a very good job.

We made, at two engineering schools, in addition, validity studies correlating success on the individual sections of the Pre-Engineering Inventory with scores on the engineering achievement tests. They also indicated that the Pre-Engineering Inventory was a useful instrument, not only for general prediction, but also for differential prediction in the different courses of the engineering curriculum of the first two years.

In looking around for project directors, we decided that one of the most important areas in which to get a project director was engineering. I am glad to say that we have been able to secure the services of a man who has been at Purdue and who was the secretary of a committee of the A.S.E.E. in early years, A. Pemberton Johnson. He is to join our staff on July 1.

Therefore, we looked forward with enthusiasm to what we could do on this project and started right in to do the very best job we could. Unfortunately—and here is where the rub comes—our enthusiasm has been dampened, not by any lack of confidence in what could be accomplished, but by the fact that there is not the financing to accomplish it. When the project was handled under the Carnegie Foundation, it was supported constantly by the Carnegie Foundation. Every one-dollar fee for the institutional testing program was matched, in effect, by a one-dollar fee that came out of either the A.S.E.E., the E.C.P.D. or the Carnegie Foundation, all of which contributed towards the project.

So when we undertook the program, it was clear, since we had no funds with which to support it ourselves, that the fees would have to be raised. The fees for the institutional program were raised to \$2.00 and for the national program to \$7.00. Not unnaturally, the change in fees discouraged some institutions from participating, and whereas two years ago some 32,000 students took the Pre-Engineering Inventory, this past year only about 16,000 took it. Therefore, there has been a marked drop in income.

Along with the reduction in income there have been increased expenses due to the additional work we have done which we hoped would lead to the improvement of the tests and their usefulness to engineering schools. We, therefore, have a deficit of \$31,000 for this fiscal year. And we, as I said, have no funds with which to finance it. Something must be done. Dean Eshbach has told you what seems to be the practical solution.

In the first place, we should drop the national program. The national program was administered, this year, on three occasions—in December, in March and it is to be administered in June. The number of candidates in December, if I remember correctly, was around 200 and in March around 1900 and around 600 in June. You cannot administer tests all over the country, set up centers at perhaps 160 different places over the country and test that number of students, without a much larger fee. The Medical College Admission Test, for example, is administered to around 15,000 students and the fee is \$10. The College Board examinations are administered in April to around 40,000 students and the fee is \$12. So it is just impossible to conduct a national program for the Pre-Engineering Inventory with so few candidates and at such a low fee.

Therefore, to take care of the institutions that have used the national program it was decided to try and get the College Board to add a test to its regular battery which would measure abilities tested in the Pre-Engineering Inventory which were not covered in Board tests. With this new test that the College Board has now agreed to add as an option, all of the factors measured in the Pre-Engi-

neering Inventory will be measured in the College Board tests so that institutions which do want a national supervised administration can get it through the College Board examinations.

But then there are the institutions that want the examinations for placement and guidance purposes, administered on the so-called institutional basis. As many institutions apparently could not afford the $2.00 fee, the alternative seemed to be to say, "All right, we will let them have the examinations for the $1.00 fee providing they do their own scoring." It so happens that in the state universities there is almost always a testing office which has a test-scoring machine and a perfectly competent staff to do the scoring, the use of which involves no cost outlay. The testing office frequently is glad to do such additional work to show that it is providing needed services. It seemed that this would be a satisfactory solution and the examination could thus be made available for a $1.00 fee. On the other hand, if scoring was desired, it could be done centrally by E.T.S. at an additional fee.

The general problem, as I see it, is a lack of unity of purpose among the engineering schools. It is not unnatural and, perhaps, it may be for the best. But it does prevent a strong program of development of tests in the field of engineering. Unless the engineering schools get together, work together with a central testing agency and support the program, it is obviously going to be impossible to provide the kinds of tests that I feel confident could be developed if there was adequate support.

In the meantime, I think it may be best to let the use of the tests subside and make them available to those institutions that want them. We, on our part, will be conducting general research in areas that are at least collateral to the engineering problem: guidance tests, aptitude tests and personality tests for use at the high school level or at college level. In the development of these tests we are likely to learn things which will be helpful in preparing tests specifically for engineering when the time comes that there is sufficient interest and enthusiasm and financial backing to support the Measurement and Guidance program in the way that I, personally, would like to see it supported.

In the News

RECORD OF 430,000 COLLEGE DEGREES GRANTED DURING ACADEMIC YEAR

Federal Security Administrator Oscar R. Ewing announced that colleges and universities throughout the United States conferred approximately 430,000 degrees during the year ending June 30, 1949—an all-time high. This estimate by the Office of Education, Federal Security Agency, is based upon returns from about 1000 of the Nation's 1200 degree-granting institutions. Earl James McGrath, U. S. Commissioner of Education, said of the survey findings, "This year's estimated total of 430,000 college degrees tops last year's previous high record of 319,000 and practically doubles the number in the pre-war peak year of 1939–40. The total includes 375,000 bachelor's or first professional degrees, and 55,000 advanced degrees, either master's or doctor's. Thirty-eight per cent more bachelor's or first professional degrees were granted in 1948–49 than in 1947–48. The number of doctor's degrees rose 29 per cent over the preceding year, and the number of master's degrees 20 per cent." Fifty-two per cent of all degrees granted during the 1948–49 academic year were earned in private institutions, the Office of Education report disclosed.

The Lamme Medal

Twenty-two distinguished educators have received the Lamme Medal. The Committee is seeking nominations for the twenty-third award, which will be made at the Annual Convention in June 1950. To get membership participation we must begin almost as soon as an award has been made.

A number of years ago The Lamme Award Committee, consisting of twelve members of the Society, set up the following rules for making the award:

1. Achievements which can be taken as proof of excellence in teaching or as having contributed to the art of technical training, will be given major consideration.
2. Only those achievements will be considered which seem to have the possibility of lasting influence or which have sufficiently stood the test of time.
3. Books, articles, contributions to method and research, which have a beneficial effect upon the teaching of engineering, will be given considerable weight in making the decision.
4. Participation in the work of Engineering and Educational Societies is not necessary for eligibility. Such participation, however, will be given due consideration if it has led to definite and recognized results in bettering technical education.
5. Achievements outside of the field of teaching, such as employment in industry, consulting work, inventions, etc., will be considered as of secondary importance in making the award.
6. Administrators in engineering schools are eligible. Only that work of Administrators, however, will be considered which has led to definite and recognized improvements in method of teaching or in the art of technical training.
7. Emeritus Professors are eligible.

Nominations should emphasize the contributions of the candidate to these major objectives. Concise statements of achievements are much more valuable to the Committee than a series of recommendations from former students and present acquaintances. Listings in Who's Who in Engineering, and such publications, give some information regarding achievements but material of this type will not give the Committee the needed information to make a valid judgment.

Statements made according to the following outline will give the information needed:

1. Preparation for teaching work—school, year graduated, degree, postgraduate work, honorary degrees.
2. Accomplishments as a teacher.
3. Advancement of the art of technical training—books, articles, contributions to method, research, etc.
4. Administrative work in engineering schools.
5. Membership and participation in Engineering and Educational Societies.
6. Engineering practice—employment in industry, consulting work, inventions, etc.
7. Other achievements.

Nominations should be sent to the Chairman of the Committee, Nathan W. Dougherty, University of Tennessee, Knoxville, Tennessee, by January 1, 1950.

The George Westinghouse Award

The George Westinghouse Award is an annual award established in 1946 by the Westinghouse Educational Foundation to recognize and encourage outstanding achievement in the teaching of students of engineering. The Award consists of $1000, together with an engraved certificate. The recipient is selected by a ten-man committee, nine of whom are appointed by the President of the Society. There is also a representative from the Foundation. The Award for 1950 will be presented at the banquet of the annual convention in Seattle, Washington, in June 1950.

The recipient of the Award must have made a significant contribution to the teaching of engineering students and shall have distinguished himself in several of the following ways:

1. Record as a teacher. (Evidence of superior teaching and guidance of students as demonstrated by records of former students, indications of unusual subject matter competence, etc.)
2. Improvements of the tools of teaching. (Textbooks and student notes, descriptions of special courses or curricula, diagrams and models, new laboratory and teaching equipment, etc.)
3. Other activities contributing to the improvement of teaching. (Material relating to the development of teachers in the nominee's department or teachers in general, the development of testing and guidance program for students, the promotion of cooperation with other types of educational units or with industry, coordination of fields of subject matter, etc.)
4. Evidence of high intellectual capacity. (Brilliance of mind as manifested by contributions to literature, degrees and honors received, etc.)

The Award has been established to encourage younger men who have shown by their past record evidence of continuing activity as superior teachers. To them the Award may serve not only as a reward but as an incentive toward further achievement.

In order to achieve this intent, it is deemed essential to limit the Award to those who have not reached the age of 45 by the date of the annual presentation.

Nominations may be made by any person, organization, or group and are to be submitted before March 1, 1950, to the chairman of the Committee on Award, Dean H. E. Wessman. College of Engineering, University of Washington, Seattle 5, Washington. Nominations must be made on forms available from either the chairman of the Committee or from the Secretary of the Society. Nominations should be accompanied by significant evidence supporting statements and claims.

On Teaching Creativeness in Design*

By E. L. MIDGETTE, J. N. MACDUFF and J. MODROVSKY

Polytechnic Institute of Brooklyn

For years industrial employers have been criticizing the "products"—graduates—of engineering schools. For just as many years teachers in the engineering schools have been critical of their own work, themselves, and of the "products" they graduated. In no field has this criticism been stronger from industry, the teachers, and the students graduated, than in the field of "designing mechanical equipment." As a result of this external and internal criticism there is no set of courses in the engineering schools that have been revised more times, or attempted in more different ways.

Each revision has introduced a new "catch phrase" to express the aim or method of approach to the problem. Now a new term has been offered to express the goal, "Creativeness in Design." Certainly this term, as others in the past, will have different meanings to different teachers. In this discussion the term, "creativeness" will be used to mean, "The ability feasibly to combine known elements of mechanisms to achieve a desired result." Stated like this, creativeness is not a new aim for design teachers. However, as the "desired result" mentioned in the definition may be one that either has or has not been achieved before, this creativeness does place accent on equipping designers for "development" rather than "modification" design. Many designers have a "knack" for this type of work, and they are in great demand in industry. Sound, thorough, modification or redesign engineers are more easily obtained. Knowing this, engineering schools and certain industries have in recent years intensified their search for means of supplying this demand.

Each of us has most likely participated in this search in one way or another, and similarly the search has perhaps followed the same pattern: (1) trying to determine the essential characteristics of the good designer and (2) trying to organize the design sequence to best develop these in students.

Characteristics of a Good Designer

The essential characteristics that mark a creative designer are not readily agreed upon. However, any list of these qualities would include: (1) a strong curiosity, (2) a broad fund of general knowledge, (3) good technical ability, (4) capacity to synthesize, (5) proper personal characteristics and (6) industrial experience.

The engineering schools have been doing a very competent job in giving the student good technical ability, but they cannot be expected to furnish the student with industrial experience. Perhaps it is not possible to do justice to all these factors in the time allotted by the usual Engineering Curriculum, but certainly an effort to do so should be made.

Curiosity is of paramount importance in solving specific problems, and in leading the designer to new applications and new products. The defining of the problems associated with a specific design is based upon questions about the design that are inspired essentially by curiosity.

The curious individual will continue to absorb knowledge from the men and machines around him, and will constantly

* Presented at the Annual Meeting of the A.S.E.E. Austin, Texas, June, 1948.

increase his fund of knowledge. This background should include information concerning phenomena, even outside of his major field of endeavor.

Synthesis is possible when curiosity and background are combined with technical ability. An intriguing example of this type of synthesis is seen in the mechanical pen on a direct recording oscillograph. The mechanical magnification of this pen is on the order of 400 to one, and the total weight is probably two grams. It must have been made by a designer who had in his general background a knowledge of the principles of operation of a chain hoist, sufficient curiosity to wonder if he could make a small chain hoist and run it backwards, and sufficient technical ability to carry out his ideas.

Confidence or a belief that a problem can and will be solved is one of the essential personal characteristics of the ideal designer. In addition, if the designer is to be outstanding, he must have the ability to appreciate the position of others, so that he will display the consideration and tolerance vital to group effort.

Assuming agreement on the above the designer teacher must present the design sequence courses so as to enhance the student's probability of developing these qualities.

The Learning Process

The steps in the learning process have been the subject of both abstract and concrete investigation for centuries. An analogy can be usefully made to the generation of a spiral about the origin made by the intersection of two rectangular coordinates axes. When such a diagram is drawn the four quadrants represent four stages in the learning process, and the spiral symbolizes the students progress.

The learning process represented this way, gives the teacher a clue to a method of presenting his material. If the subject is the design this method may be outlined as follows:

First, the student must be acquainted with a new idea, set of conditions, machine or problem, in a general discussion relating it to the students previous experience or knowledge. Second, the teacher can discuss the concept, problem, or machine, in its different aspects, under different sets of conditions and aid the student in his appreciation and appraisal of it. Third, the teacher by example or by discussion will aid the student in using his technical ability to analyze the subject thoroughly, to determine the principles involved, and how they are or may be used, thus developing in the student a critical understanding. Fourth, the student is set to work using this understanding by applying it synthetically with his previous knowledge in the actual solution of a particular problem, or in designing a mechanism or machine for a particular purpose.

The method then demands that mechanism and machine design be treated as integral parts of a single subject. Note that mechanism texts are written primarily to meet the second and third phase of the training process, whereas machine design texts are concerned with the first and fourth. The mechanism text treats subjects analytically and as studies in the motions of massless shapes. Design texts treat subjects as to their place in practice or industry, as having mass, and loads, largely leaving out motion analysis. The good teacher tries to incorporate the essence of both treatments into his design courses, thus giving the student a more complete and rational picture of the problem as a whole.

Methods of Presenting Subject Matter

The educational channels applicable to to the development of the program described above are the usual lecture and discussion periods, homework assignments and design sessions. A laboratory of mechanism and mechanical analysis may be profitably added. The design sessions and the "gadget" laboratory provide excellent opportunities for cultivating the more illusive characteristics

of diagnostic and creative ability so necessary in developing designers.

Lectures are the medium for introducing the various theories of machines. The application of mathematics, physics, strength materials, the philosophy of design, etc., are discussed at this stage. It is recognized that too often the popular theories are necessarily superficial in order to simplify the introduction of subject matter. When such instances are encountered they are emphasized to the student. The limitations of the theories are very often dramatized by extreme applications with their resulting absurdities. The popularity of the maximum shear stress criterion for failure of ductile materials is challenged by reference to membrane stresses in a spherical pressure vessel where, because the principal normal stresses are equal, zero shear stress exists and therefore the capacity is indicated infinite. This technique encourages the habit of critically assessing all proposals rather than accepting the printed word as truth.

It is observed that creative engineers continuously seek new applications of the principles involved in the more routine mechanisms. Frequent efforts are made to highlight presentations of the elements of standard machine components, with reference to actual instances of seemingly alien applications. The mechanics of the belt drive in the machine design curriculum is not taught solely because of the industrial applications of the flat belt. The principles exhibited by the analysis of the belt are more generally important and the students are cognizant of this as the important aspect of belt study. The coil spring clutch is such an application. In this case, the unique relationship between friction torque, angle of wrap, and applied load is exploited fully; but the solution substitutes steel for leather and the concept of load application is completely reversed. The net result is a clutch with a constant capacity despite large variations in the coefficient of friction. The mental process of reapplication of established machine elements by such inversions and the drastic changes in sizes or materials is a common enough technique of creative engineering as to warrant emulation.

Homework, because of its unsupervised nature, is most readily adaptable to practice in the application of theoretical analysis to well defined problems. Homework can be exploited in another direction as well, i.e., training in the art of application and arrangement of machine details. This condition is attained by assignments calling for a critical engineering analysis of the machinery that the student encounters in his every day life. If the student is encouraged to study engineering details of the machinery of his day to day contacts, and to analyze their success as functional designs, he tends to set a life long habit which will continue his development long beyond the engineering school.

A homework assignment covering the engineering analysis of pressure cookers, or a home movie camera, will leave the man with an indelible memory file of quick seals, inexpensive safety valves, intermittent motion mechanisms, surface finishes, etc. Even the lowly aspirin box is a fitting subject for study. The snap lock, details of the hinge, and speculations relative to the fabrication process contribute to the student's encyclopedia of feasible engineering solutions.

The Design Room

In all probability the most effective training for design engineering in addition to the program above is a postgraduate apprenticeship to an experienced designer in an engineering concern. Ideally the engineering program would have to be a very active one dealing with a diversity of products or a single product of a high degree of technological difficulty.

In the engineering office where such an apprenticeship might take place the following characteristic conditions are usually present:

(a) Design problems are given with only the broadest of specifications, leaving to the engineer the responsibility for restating the problem in detail and calculating or "digging-up" the missing data.

(b) The necessary calculations never seem to be exactly covered by published technical matter or theory so the engineer has to resort to judicious assumptions, "stick and string" experimentation, or seek the advice of the more experienced designers and specialists.

(c) Economical design is aided by applying commercially available components where feasible.

(d) The "know-how" within the company is hardly the property of any one man or even of a small group, but rather it is the composite knowledge of the individuals in the organization. Once the apprentice appreciates this, he will find that a satisfactory design requires a series of informal discussions with production engineering, service engineering, sales division, research departments, etc.

A session, conducted by a teacher of good experience, simulates the designer-apprentice relationship. The design problems issued are such as to be concurrent with the lecture subject matter. The strictly analytical problem is avoided in the design session. Only the broad functions are described in the assignment. An important part of the engineering performed by the student becomes a thorough enumeration of the functional requirements.

Little attempt is made to eliminate engineering considerations beyond the scope of the lectures or text. It is important for the student to learn to extend himself beyond his immediate experience. To this end, the engineer in practice resorts to library research, experimentation and personal contacts with specialists. The student is best taught to emulate this process if he is forced into the situation by the design project as it develops. He is encouraged to investigate technical literature in the library and a mechanism and mechanical analysis laboratory is provided for simple experimentation. Members of the faculty must perform the specialist's function.

To complete the simulated industrial procedure the student should refer to commercial literature. Certainly, a stack of design magazines and Sweets catalogs should be considered as minimum for design room references. In addition to the functions described above the teacher must assume responsibility for challenging the student's decisions and solution, encouraging him in the proper direction if his indecision becomes serious, and for assessing the practicability of the solutions.

The Designer's Laboratory

The development of a physical "gadget" laboratory as an adjunct to the Machine Design course is a tremendously intriguing problem. If properly handled, it should prove stimulating and useful to both the students and the teacher.

Demonstration devices can be used all the way through the machine design curriculum. For kinematic studies, simple operating models of linkages, couplings or gear trains give the student an insight that is not attained from reading. Similarly, a demonstration model of a shaft vibrating or a spring surging will enhance the physical meaning of the mathematical solution.

The attempt to expand theory to explain known practice is a logical development from the use of models. For example, if a student designs a high speed cam the effects of the inertia loading may be checked by running a model of the cam and recording its followers response. Other examples include checking calculated stresses and deflections in a curved beam or a gear tooth; or the determination of a structure's behavior under dynamic loads. As the student develops experimental technique, he begins using this type of experimentation to obtain basic design data.

The next step beyond the experimental engineering study should be a special project involving analysis, design, construction and laboratory testing. These projects should continue to the point where some developmental work is necessary. If the student can be led to analyze these laboratory tests and develop an economical method of eliminating the difficulties he is improving his ability as a designer.

Research by both the students and the faculty is undoubtedly stimulated by the laboratory. It should help to put the Mechanical Engineering school on a more equal footing with the industrial research organization.

Summary

Creativeness in Design is not a new goal for teachers of design subjects. The method of achieving the goal constitutes the problem that all are attempting to solve. Before the problem can be solved, an understanding of the essential characteristics that typify the creative designer must exist. A workable picture of the learning process is of tremendous value when organizing material to be presented, both as to the order of the subject matter and as to the technique to be used in student contact. The differences between the methods herein described and those more generally in use are very likely more in emphasis than in kind. The student is introduced to a problem in the lecture, breaks it apart and analyzes it in his home study, is given in the design room a set of performance requirements for a unit involving these principles, and asked to design a unit to meet these requirements. The engineering-apprentice relationship operates while the design is worked out. The laboratory is used when indicated to determine more specific data, or to check a model of the designed unit. After this the student will request introduction to the next problem in the classroom, and the cycle repeats.

In the News

A PROGRAM FOR INTERNATIONAL UNDERSTANDING

Education for international understanding is a fundamental responsibility of all levels from elementary through adult education. Recognition of the fact that higher education bears the responsibility for leadership is evident in the fact that more than sixty national organizations cooperated in a conference on "The Role of Colleges and Universities in International Understanding" which was held under the auspices of the American Council on Education at Estes Park this summer. Since leadership in all areas of education stems from the institutions for higher education the responsibility touches every aspect and every department of these institutions. No field of teaching or research is wholly unrelated to the advancement of international understanding.

The work of the Conference centered about four main points which were of common interest to the sponsoring organizations: (1) coordination between the campus and outside agencies concerned with education for international understanding; (2) specialized training for various types of service; (3) general education on the campus and in its surrounding community; and (4) a framework for international cooperation among colleges and universities.

Nine groups worked intensively during the four days of the conference on various aspects of these major problems. They attempted to define the responsibilities of colleges and universities for international understanding and to translate the values these institutions mean to represent and to realize in world affairs into practical terms.

A Platform for Mathematics Teachers

By W. W. RANKIN

Director, Institute for Teachers of Mathematics, Duke University
Professor of Mathematics, Duke University

We, a group of mathematics teachers (high school and college) from twenty-eight states, assembled at the eighth annual session of the Institute for Teachers of Mathematics at Duke University, August, 1948, believing all persons are entitled to a fair opportunity to appreciate and to participate in the science, technology, and business which characterize our modern society, herewith present the following Platform for Mathematics Teachers.

1. We favor a more liberal policy of interchange of ideas between teachers of mathematics and those who make frequent use of mathematics.

2. We urge that teachers of mathematics:

   a. Be equipped with a well-balanced knowledge of statistics, physical sciences, advanced mathematics, and engineering techniques.
   b. Make frequent use of learning aids in the classroom, in consideration of the fact that there are many unrealized possibilities in the laboratory method of studying mathematics.
   c. Keep themselves well informed concerning the latest materials which will help them to guide students more effectively and that they acquaint guidance counselors, class advisors, and administrators with these materials.
   d. Seek, during the summer months and in vacation periods, varied experiences in business, industry, science, and government in order to obtain a clearer understanding of the applications of mathematics and to acquire the background necessary to make functional applications which will give vitality to their teaching.
   e. Give attention throughout the schools to the achievement of genuine competence in arithmetic.
   f. Have some training in work involving the principles, skills, and understanding of elementary arithmetic, because such knowledge is basic to much of the mathematics of the secondary schools.
   g. Give heed to the repeated insistence of men engaged in business, industry, science, and engineering that "arithmetic is very important, that formulas, to be useful, must be translated into arithmetic."

3. We recommend to curriculum builders in mathematics:

   a. That secondary schools provide curricula in mathematics that will challenge those students who will be leaders in science, engineering, and research, and that they also provide functional courses for the students in general.
   b. That secondary school curricular study committees for mathematics should include, in addition to mathematics teachers, representatives from the ranks of school administrators, natural and social scientists, engineers, and business men.

c. That the general practice of teaching mathematics outside the core curriculum be continued.

4. We recommend that mathematics laboratories be established in different sections of the nation and be made available to teachers and students throughout the school year and during the summer months. The laboratories might include textbooks; books on the history of mathematics, the philosophy of mathematics, the applications of mathematics, mathematical recreations and puzzles, statistics, the psychology and teaching of mathematics; films; curriculum studies; committee reports; models, instruments, machines, charts, graphs; equipment for making models, and instruments. These materials should be chosen with a view to making mathematics more meaningful, and should serve to develop mathematical concepts and principles and to relate mathematics to the fields of science, art, business, social studies, and industry.

5. We recommend the appointment of a committee of mathematics teachers and educational psychologists to study and evaluate the most worthwhile learning aids in mathematics, with recommendations as to their grade level placement and their best use.

6. We urge that school budgets include:
   a. Provision for learning aids in mathematics.
   b. Appropriations for mathematics libraries.
   c. Funds for in-service training of teachers and their attendance at institutes, workshops, and other conferences.

7. We are convinced from experience that definite benefits accrue to teachers who participate in the work of mathematics institutes. These benefits may be summarized as follows:
   a. Contact with recognized leaders in many fields of contemporary American life.
   b. Acquaintance with a wide range of source materials in mathematics such as books, reports, instruments, machines, models, and teaching devices.
   c. Participation by attending teachers in study groups working on problems which are of special interest and concern to them.
   d. Opportunities for exchange of teaching experiences in an informal and friendly atmosphere.
   e. Acquaintance with recent experiments and trends in methods of studying and teaching mathematics.
   f. Better understanding of the laboratory method of studying mathematics.

8. We endorse the appointment of a committee to work through the National Council of Teachers of Mathematics and the Mathematical Association of America to study the organization and promotion throughout the nation of mathematics institutes and workshops for teachers, to be carried on during the summer months.

9. We recommend that teachers of all subjects and at all grade levels be acquainted with the basic concepts and principles of mathematics and science.

10. We recommend that teachers seeking elementary school certification be trained in the techniques of teaching arithmetic, including the laboratory method.

11. We recommend that a joint committee of the National Council of Teachers of Mathematics, the Mathematical Association of America, and other scientific organizations be established to collect problem materials from industry, business, the natural sciences,

the social sciences, and engineering, which will be suitable for class room use. We further recommend that such problem materials be made available free of copyright to writers of textbooks.

12. We urge an active cooperation of mathematics teachers with scientific and engineering standards associations in adopting a uniform system of units of measure. Simpler systems would expedite students' progress and enliven their interest in mathematics.

13. We recommend that the U. S. Office of Education:

    a. Appoint a specialist in mathematics who would collect and make available information on the best and latest materials useful in the study of mathematics on elementary, high school, and college levels.
    b. Give consideration to the establishment of a National Mathematics Laboratory designed primarily for teachers of mathematics. This might be similar to but much larger than the regional ones recommended earlier in this platform (plank four). Such a laboratory would give much-needed encouragement and inspiration to mathematics teachers.

14. We suggest that school administrators encourage teachers to attend mathematics institutes, visit industrial plants, scientific laboratories, and to seek experiences in business and industry, in order to become more familiar with mathematics in practice and to make their classroom work more effective.

15. We urge that college and university departments of mathematics:

    a. Study the possibilities of offering a program of work leading to the Master's degree, designed primarily for teachers of mathematics.
    b. Ascertain from experienced teachers of elementary and secondary mathematics the most useful types of courses and types of in-service training needed to maintain a high degree of excellence on the part of classroom teachers.

E.C.R.C. Publications Available

The following publications of the Engineering College Research Council are available. Orders should be sent to John Weber, Secretary, E.C.R.C., State University of Iowa, Iowa City, Iowa.

"Telling the Story of Engineering Research," the proceedings of the November, 1948, meeting of the Research Council, containing remarks on how engineers may help editors and writers deal with technical subjects; 48 pages, illustrated; paper covers. Price, 35¢ to A.S.E.E. members, 50¢ to others.

Proceedings of the 1948 Annual Meeting, containing the papers presented before the E.C.R.C. at Austin, Texas; 78 pages; paper covers. Price, $1.00.

Review of Current Research and Directory of Member Institutions, listing all active research projects by titles at the 82 institutions holding membership in the Research Council; 150 pages, indexed; paper covers. Price, $1.25 to A.S.E.E. members, $1.75 to all others.

Choice of Criteria in Applying Mathematical Methods to Evaluation and Analysis of Engineering Systems[1]

By DONALD C. MAY

Bureau of Ordnance, Navy Department[2]

Foreword

In engineering and industry, many important technical decisions are made on the basis of "broad experience" and "sound judgment." The importance of experience and judgment cannot be overemphasized. However, the technical world is becoming so complicated that these decisions may prove to be expensive and inefficient unless they are backed up by considerable scientific analysis.

Such analysis often requires many separate detailed studies; but along with these detailed analyses there has been developing a type of over-all analysis or evaluation in which the separate technical results are viewed as a whole, and the interplay of the many aspects of a problem are examined. This type of study received considerable emphasis in military matters during and after the war, and has been carried out in other fields as well, often by mathematicians. Such activities are gradually spreading to various parts of the government, industry, and other enterprises as the benefits become more generally recognized. Broad features of this type of applied mathematics have been discussed previously before this society.[3]

The present discussion is limited to one special aspect of these general analytical and evaluation studies, namely, the criteria and indices which are the "yardsticks" used.

The Role of Quantitative Criteria and Indices in Mathematical Evaluation Studies

In evaluating the quality or performance of an engineering product, the purposes may be: (a) to compare alternative designs or processes in order to choose the "best" one, in a sense which must be defined; (b) to estimate the consequences of changes in design or circumstances; (c) to predict the value of a future device or process or system, particularly in terms providing some basis for deciding on whether or how to undertake new projects. One or more quantitative indices are often used in any such evaluations, along with engineering judgment.

In simple cases, a single index may provide a suitable measure of the desired characteristics. When the product or system under study is complicated or broad in scope, several indices may be required, and the element of judgment is

[1] Presented before the Mathematics Division at the Annual Meeting, Austin, Texas, June 15, 1948. The writer is indebted to R. S. Burington for constructive comments and discussion.

[2] The opinions expressed in this paper are not necessarily those of the Navy Department.

[3] "The Role of Scientific—and Mathematical—Methods in the Management of Large Scale Enterprise," Richard S. Burington, *Journal of Engineering Education*, January, 1948, Vol. 38, pp. 366–373.

also more important. When the evaluation involves future characteristics of something not yet built or developed, the judgment may be still more important. In this case, the judgment will often have to be based less on experience and more on technical predictions, so that an even greater variety of quantitative indices may be required.

For example, if an engineer were asked simply what load a certain steel cable would support, he could measure the tensile strength and give a definite answer in tons.

In a much more involved problem, if an engineer were asked which building material would be most suitable for construction of a certain highway, he would need to determine a lot of things in quantitative form, like initial cost, ease of laying, wearing quality, safety, visibility, cost of maintenance, load carried, and many others. He might then assemble numerical tables, graphs, and other data in front of him and, on the basis of experience, he could form his judgment of all of these data. Such a problem is complicated enough so that the mere compiling of numerical data would not answer the question; and, on the other hand, it is complicated enough so that judgment on the basis of experience but without a lot of additional quantitative evidence would be an unreliable guide.

If an engineer were asked to determine the best way for a city to obtain electric power, with a view to future requirements, the need for quantitative indices would be further emphasized since the engineer would be faced with additional problems involving prediction as well as all of the complexities existing in the present situation.

Whether the example be simple or complex, both judgment and analysis based on quantitative indices are needed. One without the other is almost certainly inadequate.

In making these evaluation studies, and in using the quantitative indices, powerful mathematical-physical tools are available for predicting the operation of mechanical, electrical, and other physical systems. Mathematical statistics provides techniques for organizing masses of data, for determining trends, and for estimating the reliability of the results obtained. Mathematical probability theory enables the evaluator to show the consequences of a number of uncertain factors contributing to an operation or process, and to give numerical estimates of expected successes and failures, or limits of quality, or other features of the system under study. Further, the extensive fields of analysis, geometry, and algebra can contribute to many evaluation problems.

These various mathematical disciplines, as related to evaluation studies, naturally will continue to develop as new methods appropriate for the particular problems encountered are investigated. However, from the standpoint of most practical evaluation work, the basic mathematical tools are available, and in generous variety. The real problem usually is where to apply them, how to fit them to the problem at hand, or what to measure, in order to answer a complicated question. How should indices be selected, and how should the information they provide be interpreted?

Properties Desirable in Any One Index

Relative and absolute indices. An index or measure may be used to compare one item or method or process with another with several different degrees of definiteness. For example, if three engine designs are being compared with each other from the standpoint of torque at 1000 r.p.m., it would be possible to conclude that: (a) the torque of engine A is greater than that of B, which in turn is greater than that of C; or (b) the torques of engines A, B, C are in the ratio 10 : 8 : 3; or (c) the torques are 100 foot-pounds for A, 80 foot-pounds for B, and 30 foot-pounds for C. The last of these conclusions, in absolute terms, would presumably be the most useful, but

also harder to arrive at than the first two conclusions which are in relative terms.

Relative comparisons are often important for showing trends. Relative comparisons are also particularly suited to complicated problems where factors contributing to a numerical estimate are uncertain, where a number of outright assumptions must be made in order to arrive at the comparison, or where there are several different procedures for analysis.

In many cases approximately the same uncertainties are associated with all of the items being compared, so that by giving a relative comparison the uncertainties partially disappear. For example, in some types of tests carried out with models it might appear that process A is twice as fast as process B, and there might be good reason to expect that this same relation would hold for the full scale equipment. At the same time there might be the most serious doubts as to the scaling laws which would enable the full scale speeds of operation to be predicted from the models, so that by sticking to the relative comparison a more reliable evaluation will be obtained.

In the same manner, use of relative instead of absolute indices may cancel out or minimize the differences between various analytical systems or procedures of evaluation which might be used with the same data.

Choice of units and form. The same basic quantity can often be given in several different units or forms of expression. In this respect, the difference between, say, miles per hour and hours per mile, or other trivial variations, is not significant, except that one type of expression may be more familiar than another and hence give a more easily grasped impression of the measurements being discussed. But there are cases where various expressions of the same basic quantity may differ more importantly.

As an illustration, suppose that automatic fire extinguishers are being designed for a room containing electrical switchboards, and suppose that the effectiveness of the equipment is measured in two alternative ways. First, let P be the probability that a fire will be extinguished before more than one panel of the switchboard is destroyed. Second, let N be the number of fires which can occur, on the average, before more than one panel is destroyed. Either P or N might be a plausible measure of the effectiveness of the fire extinguisher system, and of course they really are a measure of the same thing. An increase in either P or N represents an increase in fire protection. The relation between them is $N = 1/(1 - P)$, and if $P = 0.9$ for example, then $N = 10$. Now, if a different equipment were considered, P might drop to 0.45, whereupon it appears that the second system is "half as good." But the value of N for the second system turns out to be about 1.8, so that from this standpoint the second system appears to be about "one-sixth as good." Since both indices P and N represent the same aspect of the same problem, clearly some caution is needed in interpreting them to compare the two systems. This type of difficulty is sometimes rather subtle and easily overlooked, but very important.

Differential properties. A measure or index may be of less interest for showing the magnitude of some characteristic than for showing the influence of changes in the situation. That is, the differential properties of the index may be important.

As one aspect of this, it is desirable to choose an index with the proper sensitivity to the principal variables. There is no object in having an index so insensitive that it makes completely different processes or devices appear the same when they really are not. On the other hand, if an index is too sensitive to the assumed conditions, then a variation in the value of an index, as between, say two possible processes, may not reflect an important difference in the processes, but merely a minor peculiarity in the par-

ticular numerical data used in computing the indices.

To illustrate a sensitive and insensitive index, one may consider the remote possibility that a radio station will go off the air temporarily due to mechanical failure. One index of station performance might be the probability that the station can function for a month without failure. Suppose this probability is 95% for a certain type of equipment. All sorts of improvements might be made in the equipment, and this probability might rise only to 98%. Clearly, this percentage would not be sufficiently sensitive to the state of the equipment for it to be the best measure of the value of the improvements. On the other hand, the number of minutes of failure per month might reflect quite adequately the consequences of changes in the equipment.

Often the assumed values used in computing an index are not known precisely, either because experimental data are inexact or inadequate, because unknown future conditions must be estimated, or because at some point an intelligent guess must be made. It is clearly desirable that these errors in the basic assumptions should not cause undue errors in the final index.

Likewise, in any calculation of an index wherein it is necessary to fix certain parameters and thus consider a particular "case," it is important to determine whether the result obtained depends critically on the particular case considered.

Number of variable parameters. Criteria or indices must not be too simple or too inclusive. If too simple, they will not properly take account of many factors. If too complex, they will lump together too many things, and thus not disclose important trends and factors. In particular, it is usually desirable that values of an index be computed for sets of parameters in which only one or a small number of the parameters are varied.

Boundary conditions. In determining the dependence of an index on a number of parameters, it will often be necessary to take account of boundary conditions connecting the parameters. This will be particularly important in any "optimizing" process in which an attempt is made to maximize an index by selecting the most favorable values for the parameters.

Selection and Presentation of a Set of Indices

Completeness. In general, a complicated problem has a number of different aspects which must properly be taken into account, and no single simple quantity can give the whole picture by itself. Even if it is agreed what properties any one index should have, there remains the important problem of making sure that every important factor is considered, and then adequately combining them all as a basis for a judgment or decision.

Unfortunately there is no purely formal way to make sure that some important feature has not been neglected. This is a place for practical skill and for knowledge of a field, rather than mere technical fluency with formulas or data. The mathematician as such must be particularly careful not to make purely formal and theoretical estimates of the situation he is analyzing.

The mathematician must have the advice of others familiar with design, manufacture, economic features, special physical details, use or operation, and all other pertinent information. In obtaining such help, the mathematician must maintain a broad view since the specialists' preoccupation with gadets or with inventing short cuts or better methods may tend to emphasize some particular aspect of the problem which may be very challenging, but which may not in itself give a balanced picture of the whole problem in terms of the final goal to be reached.

In addition to obtaining widespread advice, particularly in the early stages of a study, the analyst should generally make note of every parameter which appears to affect the final product. In

many cases, some indication of the accuracy, reliability, or spread in these quantities is also significant. This list will depend partly on the physics of the situation and partly on additional practical features brought out by advice of others or by the invaluable element of experience. The indices selected must then take account of all of these parameters which are important, possibly in groups related to one another. It is recognized, of course, that it may not be sensible to try to put *every* factor in the form of quantitative indices; it is merely desirable that every factor be given some consideration.

Amount of detail. In general, the most difficult problem is to be sure that all significant factors are allowed for. In practice, of course, the number of items considered must not be too great either, or the multiplicity of details will obscure the main results to be obtained. An analysis may often disclose which parameters really are important. However, even to make the analysis, some selection must be made; many a mathematical evaluation study has become bogged down because someone knew about a great many detailed factors and tried to put them all in a formula, unsuccessfully, rather than grouping some of them or ignoring some of them, in order to get the broad trends. It is always important not to over-analyze, over-evaluate, or over-use mathematical methods.

Groups of dependent indices. The various indices applicable to one problem can be subdivided into groups of dependent quantities, the separate groups being more or less independent. In considering, for example, an automobile design, there could be a number of related indices pertaining to the engine and driving mechanisms, another group pertaining to the springs or suspensions, another group pertaining to paints and coatings, and so on. In the engine group, the parameters might be closely related so that, say, an increase in power would have direct consequences in weight, and in type of bearings. The selection of a particular design would represent a balance between many interacting tendencies. Presumably these would have nothing directly to do with the paints and coatings. All of the independent groups may of course be somewhat related by cost, or by the fact that the whole product must be suitable for some particular ultimate purpose.

Simultaneous representation of many indices. It may sometimes be useful to consider some way to present many indices at once, as by an N-dimensional graph. The individual criteria or indices may be considered somewhat analogous to coordinates in a spatial coordinate system.

The concept of an all-inclusive graph is closely related to the idea of a "master index." When several indices for a given product or process have been determined, such as cost, speed of operation, total output, life expectancy, ability to meet adverse circumstances, adaptability, accuracy or freedom from failure, and so on, there may be a temptation to estimate the relative importance of each of these indices, and then by some kind of weighting factors to combine them into a single master index. This combining of indices into a single index is probably intended to be a parallel of the process of judgment which would put all the factors together with a feeling for the important and unimportant characteristics.

Some caution is needed here. However inclusive an index is believed to be, it may not tell the whole story, and generally should not claim to do so. The technical man who wants to help put judgments on a sound basis would probably do well not to try to eliminate the judgment but merely to provide some quantitative guides for it. But even if the various quantitative indices *do* take account of most or all of the important aspects of a problem, there is still some danger in weighting and combining them, since in many cases there really is no one best answer, but a lot of answers

depending on a lot of conditions. An attempt to summarize all of these results in a single number may be useless and misleading.

These analytical procedures for putting many indices together must therefore be used with caution, if at all. However, they may provide a conceptual framework which will aid in attacking the whole problem.

Some more practical procedures are available for aiding in drawing up the "balance sheet" of the many factors. Perhaps the most elementary, but most important step is to present as many factors as possible in a convenient, brief form which allows them all to be seen at once in their relations to each other. Tables and graphs can often be prepared to do this. Matrix representation of many quantities is also sometimes useful. The manner of presentation is of the greatest importance, and may warrant considerable effort.

Interpretation of a Set of Indices

It is evident that complicated problems may lead to many and complicated indices. This complexity is not an indication that the analysis is deficient, but merely a reflection of the multiplicity of factors which must usually be considered. When all of the indices are computed, classified, and presented in convenient form for ready comparison, how can their over-all implications be determined?

Balancing gains and losses. Perhaps the most important feature of most of these technical decisions is the compromise involved. Most engineering designs or decisions represent a selection, or compromise among a great many possibilities, with an attempt to balance gains in one respect with losses in another. When possible, this balancing is done so as to maximize the over-all performance in some sense.

The meaning to be attached to maximum over-all performance is itself not always obvious and easily determined. According to one point of view or one quality (or one index), one device may appear better than another, whereas another point of view will show quite a different device to be better. Uncertainties in data or other statistical variations may also make one device appear better than another without true significance. These difficulties cannot be resolved merely by further study of the indices as such, but require a deeper insight into what the real problem is, or what is really wanted of the final product.

Likewise, while a particular device may be "best" among all practical possibilities for some particular circumstances, this device may not be as good as others when the circumstances are changed. The compromise device which will be fair for a broad class of situations may be more desirable than the device which will be excellent in some limited situation.

In these and other respects it is clear that the balance among factors which is desired depends not only on the factors but on the desired quality to be optimized. The study of many indices and many cases may disclose trends which will help show what should be optimized. This may be a large contribution of the analysis.

Economic analogies. The balancing of gains and losses from various sources, the choice between several possibilities, the determination of what may be obtained at what "price" in the broad sense, and the interplay of competing factors provide an evident analogy with problems in economics. Indeed, in a sense, the problems involved often are a type of economics with an engineering setting. As such, some of the apparatus of economic theory, particularly mathematical economics, are pertinent. This is true even though the engineer may not naturally use the terminology of marginal utility, price, value, demand, and the like. Quite elaborate theories are available which goes far beyond the elementary applications of these terms.

Determining important factors. Another important aspect of balancing different factors is the determination of

the relative importance of the various parameters and developments. This problem can sometimes be examined in connection with a standard deviation S of some quantity, such as an error in performance, which arises from a number of component errors: $S^2 = S_1^2 + S_2^2 + S_3^2 + \ldots$. If it is desired to minimize S, clearly it is desirable to reduce all the S_i's. However, if one or more of the S_i's are appreciably larger than the rest, then the principal effort should be put on reducing these large S_i's. Reduction of those which are already small would contribute very little to reduction of the total S.

Indices are not always combined by so simple a method as adding squares, but in any case it is important to determine which factors have the overriding influence on the final quality, and to indicate thereby what improvements or developments are of prime importance, which are the bottlenecks, and which are unimportant.

Consideration of some but not all known factors. Many times it will not be possible to take account of some known factor, for lack of data or because of the complexity of the situation. Then it may be desirable to optimize the device with respect to those factors which can be handled analytically (noting clearly what factors have not been considered), and leaving the final decisions to other authorities who can contribute skilled judgment and experience in putting the whole picture together.

When some of the factors cannot be explicitly included in the analysis, the analyst can often help by indicating a number of possible solutions which might be considered under various conditions. That is, the analyst can say that System A will have some particular characteristics, System B will have other stated characteristics, and so on with C, D, ... The final decision can then consist of picking out that system which most nearly fits in with the whole complex of factors.

Conclusion

Development projects are now often so complex that it is essential to proceed at least approximately toward a known goal, and expend every effort to end up with a balanced system which will meet stated requirements. This process can be aided by an over-all evaluation which attempts to determine the possibilities and to put all the factors in proper perspective. A principal tool of the evaluator is the quantitative index or criterion. His contribution is to present, at various times during the development, a balanced picture of what is needed and what to expect in terms of these indices.

The use of these quantitative indices is of course pertinent to the work of the engineer, designer, inventor, and all others who have a hand in developments, as well as to the studies of the evaluator. However, it is the unique responsibility of the evaluator to look at the whole picture and to put together the information which each separate technical expert can provide on different phases of the general investigation. It is therefore his responsibility also to choose and use indices and criteria best suited to his broad studies.

Minutes of Executive Board Meeting

American Society for Engineering Education

New York City

September 15, 1949

A meeting of the Executive Board of The American Society for Engineering Education was held on Thursday, September 15, 1949, in the Engineering Societies Building, New York City. Those present were: Thorndike Saville, President, H. H. Armsby, F. M. Dawson, B. J. Robertson, F. E. Terman, J. S. Thompson, A. B. Bronwell, J. T. Mattill (guest), and D. Daum.

Report of Secretary

1. The Secretary reported that the revised teaching manual had been submitted by Dean Norris, Chairman of the Committee, to Mr. Wight of McGraw-Hill Book Company and had been accepted for publication. The Board voted to approve publication of the teaching manual as now submitted to McGraw-Hill Book Company under the terms set forth in the minutes of the General Council meeting of November 8, 1948, with the added provision that the Society reserves the right to determine whether or not it should participate in any future revisions of the manual or to withdraw from participation in the publication of the manual if it so desires. It was requested that the Secretary inform both the author and publisher of this action by the Board.

2. The Secretary reported that Mr. E. C. Koerper, Chairman of the Committee on Relations with Industry, had proposed a plan whereby he and his associates would subsidize personally the cost of publishing the manual "Speaking Can Be Easy" with the ASEE and ECPD to handle the distribution and sale of copies of the manual. This plan would eliminate the necessity of either society subsidizing the initial cost of publication of the manual. The Board voted that the Secretary be authorized to proceed with negotiations with Mr. Koerper and his Committee on this basis.

3. The Secretary announced that Dean R. C. Ernst, Chairman of the Southeastern Section, had reported that the research grant (which expired June 1, 1949) made to the Southeastern Section by the General Education Board had been renewed for another two years.

4. The Secretary reported that the proposed constitutional amendments had been submitted to the entire membership for ballot.

5. The Secretary submitted estimates obtained from the printer regarding the adoption of a new format for the Yearbook issue of the Journal. This proposed change would not result in any saving during the current year but would effect a saving of $700 in future issues of the Yearbook. The Board voted to adopt the new format.

6. The Secretary reported that the membership drive was off to a good start, that chairmen had been appointed for each of the states and that publication was underway of the descriptive pamphlet on Society activities entitled "Dynamic Influence in Engineering Education." It was the opinion of the Board that since this booklet had been mailed to

all individual members of the Society last year, it would not be necessary to mail it to present individual members of the Society this year. The booklet will, however, be distributed to all members of the Membership Committee and to those whose names are submitted as prospective members.

7. Arrangements for the Kansas City meetings of the ECAC, ECRC, and General Council were discussed.

Report of Treasurer

1. The Treasurer submitted a report of receipts and disbursements for the period July 1 to September 13 of the current fiscal year Since the duties of the Secretary and Treasurer are very generally stated in the Constitution and By-Laws of the Society, he recommended, and the Board voted to continue, the routine procedure which has been in effect for recent years as follows:

a. The Treasurer co-signs checks and vouchers, examines all monthly bank statements and the final audit, and is official advisor to the Executive Board in all financial matters.

b. The Secretary is responsible for all properties of the Society, including the bonds, which are now in the vaults of the State Bank and Trust Company, Evanston, Illinois.

c. The Secretary receives, accounts for, and disburses the funds of the Society; submits quarterly statements; and, in cooperation with the President and Treasurer, prepares a proposed annual budget for consideration of the Executive Board and General Council.

d. The Secretary is responsible for having the books audited annually. For the past two years, this has been done by Professor E. C. Davies, CPA and Head of the Accounting Department of Northwestern University.

e. The Secretary and Treasurer of the Society are bonded in the amount of $10,000 each.

The Board instructed the Secretary and Treasurer to prepare an appropriate statement of the duties of their offices to be submitted to the Board for consideration at its next meeting and possible inclusion in future revisions of the Constitution and By-Laws.

2. The Treasurer announced the purchase of $10,000 in U. S. Government Bonds as authorized by the Board at its meeting on June 20, 1949.

Report of the Vice President in Charge of Divisions and Committees

Vice President Robertson reported that he is planning to write several letters to the Divisions and Committees during the current year. The first of these letters, outlining the duties of Division officers and informing them of their budget allotments for the year, has already been distributed. Vice President Robertson indicated that another letter will be distributed soon covering items acted upon by the Board at this meeting which affect Divisions and Committees.

Report of Vice President in Charge of Sections and Branches

Vice President Armsby reported that the Committee on Sections and Branches has been reorganized, and is now composed of the members of the General Council representing Sections. It was felt that this would give the Sections a closer relationship to the activities of the Society, since it would insure larger representation of the Sections at meetings of the Committee, and would result in one man being responsible for reporting to each Section on actions taken by the Society.

Vice President Armsby reported that he is also following up requests of various schools regarding the formation of branches at their institutions, and will report on results at the next meeting of the Board.

He suggested that the Section meetings are the logical place to encourage activity on the part of the younger members of the Society, and the Sections

should be encouraged to seek out younger men for participation in their programs.

The Vice President also reported that his Committee is commencing work on the preparation of a Sections manual as proposed by the Executive Board at a previous meeting.

Enrollment Statistics

Samples were distributed to the Executive Board of the forms which will be used this year in collecting the enrollment statistics under the joint sponsorship of the ASEE and the U. S. Office of Education. The Board agreed that the Society would publish breakdown figures on these statistics for only those schools having one or more curricula accredited by the ECPD, and only totals will be included as collected for other engineering schools listed in the U. S. Office of Education list. It was voted that the Secretary should attempt to determine the method of accreditation of Canadian schools for use in selecting those Canadian schools to be included in the ASEE listing.

Report of ECRC

Vice President Dawson submitted a report of the ECRC giving names of new Committee members for the coming year and outlining their proposed panel discussion program for the coming meeting in Kansas City.

The Vice President announced that the ECRC proposes to publish a brochure entitled "The Quest for the Best" presenting case history results of fundamental research conducted in universities and colleges. This proposed publication was approved by the Board.

Vice President Dawson also announced that the work of indexing the 1949 Review of Current Research had been completed and that copies of this Review would be distributed in about ten days.

At the suggestion of President Saville, Vice President Dawson will prepare a statement of the major objectives of the ECRC for the guidance of the ECRC Executive Committee and the Executive Board.

Committee on Census

President Saville announced the appointment of a temporary committee, under the Chairmanship of Vice President Armsby, on collaboration with the Census Bureau. The Board approved the action of this Committee previously taken and recommended that President Saville write a letter to the Bureau of the Census endorsing the report of this Committee and the recommendations they had made.

Committee on Teaching Aids

Copies were distributed to the Board of the report of the Committee on Teaching Aids, prepared by Professor W. J. King, Past Chairman. Professor Carl W. Muhlenbruch has been appointed new Chairman of this Committee. The immediate objective of this Committee is to appoint subcommittees to review, evaluate, and accredit the visual aids presently available and to encourage the companies manufacturing visual aids to consult with the reviewing committees and pay expenses involved. The reviewing committees will then prepare a report on the use and value of the various visual aids. This report will be put in bulletin form and will be distributed by the Society to the engineering colleges.

Committee on Improvement of Teaching

A steering committee for the Committee on Improvement of Teaching, under the Chairmanship of Professor B. R. Teare, Jr., has been appointed. The steering committee will formulate a statement of the problem and a proposed method of approach. The steering committee will then be replaced by a full committee which will complete the study and prepare a report for submission to the General Council.

Annual Meeting

1. President Saville submitted a proposal regarding the procedure for nomi-

nation and election of officers at the annual meeting. The Executive Board recommended that this procedure be submitted to the General Council for approval: (*a*) A preliminary canvass of possible candidates would be made by the new Nominating Committee after the elections at each annual meeting. (*b*) Nomination ballots would be published in the December and January issues of the JOURNAL with prominently displayed notice to members to return them. (*c*) An informal ballot by letter would be taken by the Nominating Committee in March or April. This will be followed by a second informal ballot in April or May. (*d*) The Nominating Committee would meet on Monday afternoon at the Annual Meeting for the purpose of making the final nominations. (*e*) The report of the Nominating Committee would be presented and election of officers would be held at the Wednesday morning General Session.

This plan would encourage nominations from the Society membership, would enable the entire Nominating Committee to participate in nominating procedure, and would facilitate a meeting of the newly elected officers and retiring officers during the annual meeting of the Society.

It was also suggested that the Vice President in charge of Divisions suggest to the Division Chairmen that they elect officers prior to the Wednesday General Session so that the new and retiring Division officers could discuss plans for the succeeding year.

2. To minimize the conflicts of conferences having similar interests at the annual meeting, the Board voted that the ECAC and ECRC meetings would be considered as conferences, and that meetings of Committees and Divisions with non-conflicting interests would be scheduled at the same time as the meetings of the two Councils.

3. The Board approved a plan providing for two general sessions to be held on Wednesday morning and afternoon and a banquet on Thursday evening. The Research and Administrative Councils will hold their principal meetings on Tuesday morning and Thursday morning, respectively, concurrently with other conferences which have non-conflicting interests. Registration will be on Monday morning, June 19, and conferences will be concluded on Friday noon.

4. The Board voted that the February first deadline for submission of program material by the Divisions and Committees be continued in order to make it possible to complete the scheduling of conferences, luncheons, dinners, etc., with the host institution and get the preliminary program printed and in the mailed by the end of April.

Report of the ECAC

Vice President Terman announced the details of the ECAC program for the Kansas City meeting. The theme for their program is "Atomic Developments Present Engineering Education with New Problems."

Vice President Terman reviewed the present Committees of the ECAC. It was suggested that the ECAC might make studies of methods of faculty evaluation, teaching loads in engineering colleges, and other administrative problems. It has also been suggested that a new investigation of engineering education, similar to the 1923–28 report might be undertaken at this time.

Society Committees

President Saville made a number of recommendations intended to simplify and correlate the Committee structure of the Society. The following are actions taken by the Executive Board:

1. The Board voted to establish a Coordinating Committee on Relations with Government, this Committee to be composed of representatives from all of the Society committees that participate in

government relations and whatever other members the President of the Society may desire to add. The Coordinating Committee will correlate the activities of the individual committees and investigate areas of relationships with government which are not handled by existing committees.

2. The Board voted to discontinue the Committees on Professional Development, Functions of the Vice Presidents, and Teaching Manual.

3. The Board voted that our representation on the Committee on Status and Deferment of Engineers be discontinued and that this subject be referred to the Administrative Council.

4. It was suggested that the Research Council set up a Committee on Graduate Studies which would coordinate its activities with those of the Division of Graduate Studies. The Vice President in charge of Divisions and Committees was asked to suggest to the Chairman of the Division of Graduate Studies that the chairman of the new committee under the ECRC be appointed a member of the Executive Committee of the Division of Graduate Studies.

5. The Secretary presented the recommendation of the Committee on Relations with Industry that a committee of the Society be appointed to study the problem of financing of higher education. Vice President Armsby pointed out that a similar committee had been appointed by the Association of American Colleges which had been given a substantial subsidy to study this problem. The Executive Board appointed President Saville and Vice President Armsby to investigate this matter with the recommendation that a prominent member of the Society be appointed to work with the committee of the Association of American Colleges.

6. The Secretary presented the Report of the Interim Committee for Young Engineering Teachers. This report outlined the objectives of the Committee, the activities in which the Committee might engage, and the topics which might be of pertinent interest to young engineering teachers. The report was referred to the General Council with the following recommendations:

(*a*) A conference of young engineering teachers be held at the annual meeting, the program to be arranged by the Committee.

(*b*) Approval of the recommendation of the Committee that the activities of this new group be brought to the attention of administrative officers in engineering colleges.

(*c*) These activities to be continued on a committee basis, the Interim Committee making recommendations as soon as possible to the President for additional members of thhe Committee. The Interim Committee should continue to serve throughout the year, and those members of the Committee who are over the age limit recommended by the Committee can be replaced by new appointments at the end of the year.

(*d*) That Professor Schwartz, Chairman of the Committee, prepare a short article on the activities of this Committee for publication in the JOURNAL.

UNESCO

President Saville reported on his attempts to have the Society included as a permanent institutional representative on UNESCO instead of on a rotating basis. He will continue to seek permanent representation.

The Board recommended that Vice President Armsby serve as liaison representative of the Society to cooperate with Mr. Green of the Department of Commerce in legislative matters dealing with engineering education in President Truman's Point 4 program.

James H. McGraw Technical Institute Award

The Executive Board approved the resolution submitted by the Technical

Institute Division to announce the name of the recipient of the James H. McGraw, Sr., Award in Technical Institute Education at the annual banquet.

Dues

The Board recommended to the General Council that the $5.50 and $6.00 dues status as listed in the Constitution and By-Laws apply only when a member's full-time services are related to the activities of educational institutions.

Respectfully submitted,

ARTHUR B. BRONWELL,
Secretary

Candid Comments

A SLUG AT THE SLUGGERS

If the recent article by Professor R. C. Binder "The Case for the Sluggers" (JOURNAL OF ENGINEERING EDUCATION, June 1949) were to be delivered to a class of students, we can well imagine that the following discussion would take place:

Prof.: Are there any questions on the use of the slug in engineering?

Student: When I go to the store and buy butter, they sell it by the pound and not by the slug. Why is that?

Prof.: Unfortunately, the pound mass is the legal unit of mass in the United States.

Student: But Professor, when I go into your laboratory and use your platform scales or your precision balance, the answer is also given in pounds mass.

Prof.: Ah———, yes, these instruments all measure *mass* and are calibrated to read in pound mass units (and this calibration is independent of the local acceleration of gravity).

Student: Do we have in the laboratory an instrument to measure weight (i.e., gravitational pull)?

Prof.: Errr, I think I have an old spring scale that could be used, but it is not very accurate.

Student: Then this w that you are talking about we have no way of measuring in the laboratory?

Prof.: Ye . . . sss, we can measure the mass in pounds on our balances and then divide by 32.1739 and then multiply by the local acceleration of gravity, g.

Student: And, to get the mass in slugs, you divide this weight by g, is that it?

Prof.: Exactly.

Student: Well, it seems to me that all we are doing is using the pound mass in all our measurements and reasonings and then dividing by a fixed number 32.1739 which is not the acceleration of gravity but merely shows that the slug unit of mass is 32.1739 times the mass unit. Moreover, since you do not measure weight in any of your laboratory measuring devices, I do not see why you insist on showing it in your calculations in the form, w/g.

E. F. OBERT,
W. H. ROBERTS,
J. F. BAILEY,
G. M. BROWN,
Northwestern University.

* Comments on articles appearing in the JOURNAL or other items of current interest to engineering educators will be published in CANDID COMMENTS. Contributions should be sent to the Secretary. They should not exceed 500 words and may be edited where necessary.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	Spring, 1950	D. M. Griffith, Bucknell University
Illinois-Indiana	Purdue University	May 13, 1950	D. S. Clark, Purdue University
Middle Atlantic	Columbia University	Dec. 3, 1949	R. T. Weil, Jr., Manhattan College
National Capital Area	Washington, D. C.	Oct. 4, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Nov. 3, 4, and 5, 1949	C. J. Posey, University of Iowa
Pacific Northwest	University of Idaho	1951	A. S. Janssen, University of Idaho
Pacific Southwest	Stanford University	Dec. 28 & 29, 1949	R. J. Smith, San Jose State College
Southeastern	Virginia Polytechnic Institute	April 20, 21, & 22, 1950	H. G. Haynes, The Citadel
Southwestern	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University
Upper New York	University of Rochester	Nov. 18–19 1949	H. W. Bibber, Union College

Officers of Councils, Divisions, Committees and Sections

ENGINEERING COLLEGE ADMINISTRATIVE COUNCIL

CHAIRMAN: F. E. Terman, Stanford University.
SECRETARY: J. H. Lampe, North Carolina State College.
EXECUTIVE COMMITTEE: A. S. Adams, O. V. Adams, R. E. Vivian, F. W. Wilkinson, K. H. Condit.
MANPOWER COMMITTEE: L. M. K. Boelter, *Chairman*, University of California.
MILITARY AFFAIRS COMMITTEE: D. B. Prentice, *Chairman*, Scientific Research Society of America.
COMMITTEE ON SECONDARY SCHOOLS: E. D. Howe, *Chairman*, University of California.

ENGINEERING COLLEGE RESEARCH COUNCIL

CHAIRMAN: F. M. Dawson, State University of Iowa.
SECRETARY: J. I. Mattill, Massachusetts Institute of Technology.
EXECUTIVE COMMITTEE: R. M. Green, F. G. Hechler, A. G. Conrad, M. O. Withey, G. A. Rosselot, F. E. Terman, J. H. Hamilton, T. L. Joseph.
COMMITTEE ON RELATIONS WITH MILITARY RESEARCH AGENCIES: A. P. Colburn, *Chairman*, University of Delaware.
COMMITTEE ON RELATIONS WITH NON-MILITARY RESEARCH AGENCIES: R. A. Morgen, *Chairman*, University of Florida.
COMMITTEE ON RELATIONS WITH INDUSTRIAL RESEARCH AGENCIES: H. K. Work, *Chairman*, New York University.

Committees, 1949–50

EXECUTIVE BOARD: Thorndike Saville, *Chairman*, New York University, New York, N. Y., H. H. Armsby, F. M. Dawson, B. J. Robertson, F. E. Terman, J. S. Thompson, A. B. Bronwell.
PROGRAM: Members of the Executive Board.
PUBLICATION: A. B. Bronwell, *Chairman*, Northwestern University, Evanston, Illinois, Thorndike Saville, C. J. Freund.
CONSTITUTION AND BY-LAWS: W. C. White, *Chairman*, Northeastern University, Boston, Mass., J. W. Cell, H. O. Croft, E. D. Howe, F. L. Schwartz, C. E. Tucker.
ENGINEERING ECONOMY: W. D. McIlvaine, *Chairman*, University of Alabama, University, Alabama, E. D. Ayres, H. R. Beatty, C. E. Bullinger, G. Filipetti, E. L. Grant, J. M. Juran, E. Laitala, K. M. Loughmiller, H. E. Nold, A. J. Still, E. J. Taylor, Jr., J. K. Walkup.
ENGINEERING SCHOOL LIBRARIES: E. A. Chapman, *Chairman*, Rensselaer Polytechnic Institute, Troy, N. Y., Madeleine Gibson, W. H. Hyde, J. B. O'Farrell, D. A. Webb.
GEORGE WESTINGHOUSE AWARD: H. E. Wessman, *Chairman*, University of Washington, Seattle, Washington; for four years, N. A. Christensen, R. E. Vivian; for three years, V. L. Doughtie, W. L. Everitt; for two years, E. B. Norris, H. E. Wessman; for one year, R. C. Gibbs, A. D. Moore; C. A. Powel, *Ex-Officio*.

INDUSTRIAL HYGIENE, SAFETY AND FIRE PREVENTION: J. J. Ahern, *Chairman*, Illinois Institute of Technology, Chicago, Ill., W. N. Cox, G. H. Dunstan, D. E. Henderson, W. F. O'Connor, N. A. Parker, J. K. Walkup.

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Editorial—Counselling Engineering Students

By HENRY H. ARMSBY

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The situation in which the engineering colleges find themselves at the present time calls for greater attention to programs of guidance and counselling than they have received from engineering educators in the past. A.S.E.E. might well take the lead in this important activity, especially in the Sections and Branches, which are closer to the problem than is the National Society.

It seems evident that for at least some years to come engineering graduates will face much keener competition than has been the case in recent years, and they may even be seeking admission to an overcrowded profession. Fairness to our students, present and future, demands that they be adequately informed as to the requirements of the engineering profession, and the employment opportunities in it. They should also be advised of the factors tending to increase the nation's needs for well-trained engineers, which were discussed in the report of the A.S.E.E. Manpower Committee, and of the great demands and opportunities for graduates of good technical institute courses, which have been pointed out in numerous surveys and reports. They should be further advised of the well known fact that engineering education has great value as general education and forms a good foundation for work in many professions other than engineering.

In view of this latter fact, it is improbable that engineering schools in general will impose rigid limitations on enrollments in accordance with local or national needs for graduate engineers. However, it is highly important that they make every effort to insure that the education they give their students shall be as effective as possible, by making certain that they are devoting their energies and their funds to those students who can best profit from them.

Every effort should be made to identify through aptitude and achievement testing programs in the high schools those students who have the aptitudes and abilities which will qualify them to be successful engineers and scientists, and also to identify those who would profit more by a good technical institute training than by attempting a four-year college course in engineering or science. This should be done early enough in the high school course to give students an opportunity to adjust their high school courses to their future plans. Efforts should be made to encourage the well-qualified students to continue their education beyond high school, and should be accompanied by some form of help for those who need help, financial or otherwise, to achieve their ends.

This program will call for close cooperation of the engineering schools with each other and with high school authorities, such as has been the objective of the A.S.E.E. Committee on Secondary Schools ever since its establishment. Probably the program can best be promoted by visits to high schools by representatives of the engineering colleges and the engineering profession, provided the activities of these visitors are

directed toward genuine guidance rather than propaganda for individual institutions.

The college admission process should include an adequate testing program, such as has been advocated by the E.C.P.D. Committee on Selection and Guidance, a program sufficiently comprehensive to insure that those students actually admitted are well qualified to profit by the work of an engineering school. After admission to college a well thought out counseling program should be in effect to determine which students are most likely to succeed in the various functional divisions of engineering such as construction, research, design, teaching, etc. Consistent efforts should be made to furnish opportunities for students to confer with practicing engineers, research workers, teachers, etc., as additional means of guiding each student into the work for which he is best adapted. If possible, curricula should be modified to fit the needs of these various groups and at least those students qualified for research and teaching should be encouraged in every possible way to continue their education beyond the bachelor's degree.

The counselling program should not be limited merely to vocational guidance, but should also include counselling on psychological, emotional, and social problems, which are experienced not only by the maladjusted, but to some extent by all students. Scholastic failures are often due to unsolved social problems or to emotional upsets rather than to mental or physical disability. Students must learn that we have to live with differences—differences in religion, in cultural background, in economic and political backgrounds—and that we must learn to cooperate with those whom we do not like as well as with those whom we do like.

Engineering teachers can make valuable contributions to all the phases of counselling mentioned above. In fact, counselling should not and cannot be confined to the Office of an official counsellor, but is constantly going on through the students' person-to-person relationships at home, on the campus, and in the classroom, and every teacher is, consciously or unconsciously, a counsellor for his students.

There is need for all engineering teachers to appreciate the value to the students and to society of a well rounded program of counselling, and their own important part in it.

Pre-College-Entrance Orientation in Engineering

By L. E. GRINTER

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Synopsis

It is here suggested that the period between acceptance of a student into a college of engineering and his final registration therein be used on a part-time basis as a period for certain orientation readings and refresher studies. A week or more of this period, which is commonly at least two months in length, could be taken over by the engineering college either for required reading resulting in a formal report or for informal recommended reading and study. No equivalent amount of time seems available in the freshman year.

Orientation and Refresher Courses

Over the past two decades orientation programs for freshman engineers have developed and waned in sympathy with other pressures that have grown up within the borders of our engineering curricula. No doubt the great pressure for growth of the humanistic-social stem of the curriculum has had its influence in reducing formal orientation courses in the freshman year. Whether the orientation plan of a given institution involves inspirational lectures, assigned readings or problem work, time must be used to make the plan successful. The arrangement of two or three days at registration for a few lectures and an inspection of the Campus has its merit in orienting the student to his new environment, but it serves only a minor function in broadening his useful knowledge of the engineering profession.

A related activity that finds little attention within the formal curriculum of the freshman year is a planned refresher of critical high school studies. When veterans began to return in 1945 there was great emphasis immediately upon refresher courses. It was the common observation that veterans profited by such studies, and no doubt many were thus saved from early failure in regular courses. As the veterans began to be replaced with recent high school graduates, refresher courses disappeared. However, it seems probable that the lower one-third of present freshmen need refresher work fully as much as the veterans of 1945. The percentage of failures in mathematics, chemistry, physics and mechanics during the freshman and sophomore years testifies forcefully to inadequate preparation.

Within the present framework of four-year curricula little is likely to be done about formal orientation or refresher courses. Students who are obviously deficient in mathematics are often given additional hours of instructor contact for the standard credit in freshman mathematics, but the average student starts his study of college algebra after a two-year lapse of mathematical thinking. It is easily observed that incapacity to make the transition from high school to college during the first six weeks results in a frustration that is never overcome by many students. The result is probably unnecessary failures and an increased percentage of students who develop a "get-by" attitude.

Before the war relatively few of our institutions accepted their students before early fall. Now it has become common to require applications in the spring or early summer. No doubt there will be some retrogression in this regard as applications reduce, but procedures once established tend to maintain themselves. Hence, for large numbers of students admitted to our engineering colleges a period of two to four months will continue to occur between admission and final registration. This then is the only free period available for orientation and refresher reading and study. As yet we have made no formal attempt to capitalize upon the use of this time.

Pre-College-Entrance Reading

The question proposed is whether the period of collegiate influence upon the student might not be moved backward to the date of college acceptance by suggested or even required readings of an orientation and refresher nature. Could not the study of a single book or even a few selected chapters be made to provide a useful transition into the engineering collegiate world? It is of no moment that the ideal text may not be available for immediate adoption. Several useful books do exist, and others will quickly appear as soon as a demand for their use becomes evident. Some institutions might wish to provide without charge mimeographed notes with suggested orientation readings readily available in any library and with problems to test the student's need for refresher studies in suggested textbooks.

A general outline of reading or study that the writer believes would be of benefit to essentially all students accepted for entrance into a college of engineering would be as follows. (1) An explanation of the kinds of work performed by engineers, scientists and technicians as a background for formation of a choice of vocational objective. Information could well be included here covering certain professional attitudes that need to be instilled. (2) A review of high school mathematics through the medium of problem solution of an elementary technical nature. (3) Sufficient material to teach the language of chemistry and an insight into the meaning of the chemical equation. (4) At least an explanation of why technical drawing is considered the language of engineering. (5) Some elementary insight into problems of electricity, heat and mechanics with the purpose of creating interest in the later study of physics.

For most students only a part of these five objectives could be accomplished between college acceptance and registration. But, if no more were achieved than to get the student to spend a dozen hours on orientation reading and an equal period in reviewing mathematics, the results would be significant. Surely all students could be expected to give at least one week to such pre-entrance reading.

Conclusion

After looking objectively at this program one may well wonder why institutions have taken little active responsibility for encouraging students to prepare in this manner for college entrance. Considering our clear responsibility for doing everything possible to aid students in having a successful college experience it appears that this pre-college-entrance period of orientation and refresher study needs to be capitalized. To be most effective this program should be organized as a regular extension service. But useful results could no doubt be achieved on a more informal basis of recommended reading.

Engineering Literature and its Role in Pan-American Development[1]

By EDWARD P. HAMILTON

President, John Wiley & Sons, Inc., New York

In my talk to you today, I shall keep before me three related points of view: first, that of an engineer, because I was once in engineering; second, that of a person concerned with education; third, that of an individual, deeply interested in the technical and intellectual cooperation of all of the Americas.

Our meeting here in Brazil can also be said to have the same three related points of view. As engineers, we are extremely interested in the interchange of our own specialized knowledge. But we are also interested in extending our knowledge, both to our own colleagues in the countries we represent and to the engineers and scientists of future generations whom we shall have to educate. And naturally, we are here to foster and nurture unity which exists among us as engineers of a single geographical area: the American hemisphere.

This First Pan-American Engineering Congress, arranged by the South American Union of Engineering Associations, gives us therefore the opportunity to explore some of the engineering and the educational factors contributing to the progress and development of the American nations. The officials who have done such excellent work in organizing the Congress are to be congratulated for the results of their efforts. I am deeply grateful for the opportunity to be here and to express a few of my own thoughts on the influence and importance of technical book publishing in Pan-American development.

As we well realize, science and engineering today have no national boundaries. We engineers, throughout the Americas, and throughout most of the rest of the world, are all striving toward the same goal. Our role is one of inter-American cooperation in order to ensure that science and technology are developed to their fullest degrees with the aim of making the world a progressively better place to live in. We must not, engrossed as we are in the problems of our own professions and specialties, lose perspective and forget the necessity and importance of scientific interdependence among our nations if the full potential of technological advance is to be exploited for the peace, well-being, and security of new generations. We must emphasize the inter-American function in all our activity: in our own professions and work, in teaching the young people who will follow us, and in writing about scientific and technical achievement in the now internationally-circulated technical periodicals and books.

Scientists and engineers on the whole are among the most ardent proponents of the free and unrestricted communication of ideas to contemporaries in other lands and on other continents. As I see it, there is no better means for inter-American technical cooperation than through the interchange of scientific thought. Eminent authorities in science and engineering in our age are not concentrated in any one country or group of countries as they have been in the past. They are found everywhere.

[1] Presented at the First Pan-American Engineering Congress, Quitandinha, Brazil, July 20, 1949.

No matter what our native tongue, our background, our discipline, our national activities, we do speak the same language of science and technology. Our mathematical formulas and our physical laws are the same, even though in certain cases our nomenclatures are not alike. This is fortunate and must serve as a basis for initiating and continuing our hemispheric and world-wide relationship.

Inter-Continental Cooperation

Of course, international cooperation results from and is hastened by wartime necessity. But there is certainly no reason why science and technology should not cross national boundary lines in the practice of peace.

By lack of contact with colleagues in other countries, we have deprived ourselves occasionally in the past of some of the stimulus needed by science to progress further. On the other hand, by making international contacts, as we are doing at this meeting and as we shall do at future meetings of engineers throughout the world, we can actually help to make science and technology the dominant forces they should be.

For fear of creating the impression that we Americans have not been successful in our efforts to bring about inter-American cooperation in technical and scientific areas, I should like to mention certain activities which indicate that we have already made definite progress.

First—International meetings such as the great one we are attending today. Others especially worthy of mention are the Pan-American Mining Congress, the Inter-American Congress of Sanitary Engineers, the Sixth Pan-American Architectural Congress, the South American Congresses of Chemists, the fourth one of which I attended in Chile last year, which included chemists and chemical engineers from a number of countries outside of the South American Continent.

Second—The interchange of information between such great research institutions as the Instituto de Pesquisas Tecnológicas at São Paulo, the Instituto Nacional de Tecnológia at Rio, and Instituto de Tecnológia Industrial at Belo Horizonte, with similar centers in other countries.

Third—The interchange of professors and of students between our countries.

Fourth—The Pan-American Union which, especially in recent years, has devoted more attention to the joint application of scientific and technical resources to the solution of those problems limiting human welfare.

And from my own country there are the excellent journals Ingeniería Internacional Construcción and Industria published by McGraw-Hill Publishing Company.

The publication of Adelantos de Ingeniería, resulting from the combined efforts of the Engineers Joint Council's Commission on Latin America and the National Research Council.

The Research Council Bibliography of Scientific, Medical and Technical Books of the U. S. A., volume two of which, covering books issued from 1945 through 1948, is now, I believe, in the printers' hands.

Also the Quarterly Book List of our Library of Congress.

Mention should also be made of the excellent work of the Inter-American Committee on Scientific Publication which has established a program for regular publication in leading North American journals of outstanding papers by Latin American scientists and technical men.

Coming to the subject of technical books, I think that it will be acknowledged that their interchange between our countries has a profound effect in the internationalization of technology and science. All you engineers who are here today recognize their value.

You were taught from them; you are teaching the next generation with technical books. Books are your professional tools, and reflect your progress and achievements. The distribution of such books as we are speaking about—and naturally other printed technological information—has hastened the spread of

science and technology in a way that can hardly be matched by any other form of communication. Scientific developments have been followed almost immediately and invariably by books presenting theory, techniques, applications, and related matters. Today the engineer must not be any less practical than he was in the early days, when, as an example, the railroads were in their infancy. Now he must have in addition a sound theoretical knowledge. I might observe here that I have been impressed by the excellent working knowledge of higher mathematics among South American engineers of my acquaintance. Engineers also profit from a working knowledge of other branches of science, perhaps chemistry and biology, depending on their own specializations.

Reviewing the history of technical book publishing—apart from purely scientific works, some of which appeared as early as the 17th century—we see the beginnings in the late 18th century and the early days of the 19th. The evolution of formal technical literature has been gradual, although with occasional bursts of speed, particularly during wars. Tracing its development in the history of my own company, I find that we published some semi-technical books as early as 1815 and 1819.

Early Books Used Widely

Many of the early technical books published in the U.S.A. were famous and widely used throughout the Americas. Such works as Drinker's "Tunneling," Wellington's "Economic Theory of the Location of Railways," Whipple's "Art of Bridge Building," the first two published by my firm and the third by the D. Van Nostrand Company, and the Trautwine civil engineering books, all published in the '70s and '80s, were well known by an older generation of engineers in all our countries.

From these early days on, there developed a great North American technical literature, but up until World War II, Latin American engineers, from what I have been told, did not depend upon it to the extent that they did on books from Germany, France, Italy, and Spain. The Spanish publications, however, were largely translations from German or British books. From 1940 on through the war Latin American countries, perforce, turned to North America for their *imported* books. I emphasize the word "imported" because a Latin American technical and scientific literature is developing and in the future with its many able engineers and scientists is certain to grow. Just as one example of an excellent book from this continent I might mention the book on hydraulic engineering by Professor Dominguez Solar of Chile.

Looking around the bookshops of some of the capital cities of this continent one is impressed with the many splendid technical books originating in many countries; in other words, no country has a monopoly on technical books, any more than they have on able engineers or scientists.

Going back a little, up to the time of World War I, books of an advanced technical or scientific nature were rarely published in most of the countries of this hemisphere, chiefly because of the limited markets for them. This situation was especially true in the United States, where we publishers seemed to have been largely concerned with books at the undergraduate level. However, as a result of World War I, there were developments which hastened technological advance and the consequent need for more books dealing with specialized areas of science. Even then there were many gaps in the scientific literature in the United States and Great Britain which were left to other countries to fill, notably Germany and France, if indeed they were filled at all.

With the advent of World War II, engineers and scientists were faced with many new problems of staggering proportions—new direction-finding apparatus, higher-speed engines, construction of artificial harbors, the atomic bomb, and countless others. When peace came, publishers realized that we had to work

fast to keep up with new scientific developments. These efforts have led to investigation and publication in areas either completely new or undeveloped so far as the literature is concerned.

Unit Standardization Urged

The demand for these new books, in fact for all books, has been great in this post-war period, but there are difficulties that stand in the way of freer distribution from country to country.

First of all, there is the language barrier. Although a good many of us are familiar with each other's language, the majority of us are negligent in learning Spanish, Portuguese, English, or whatever language is required so that we can use technical books of foreign origin profitably and proficiently. We are, it is true, having our important scientific works translated into each other's languages, but there are problems which limit extensive translation programs, among the most difficult of which to overcome is that of costs. The cost problem is especially prohibitive in the conversion of English units into the corresponding metric units, and vice versa. It is my most earnest hope, if I may interject a slightly different thought at this time, that we will see in the near future a universal standardization of units, symbols, definitions, tabular and formular data and scientific nomenclature.

Another difficulty is the economic problem which prevents booksellers from freely importing books which are greatly needed. This difficulty is, unfortunately, likely to continue until the world's finances are straightened out.

Related closely to this difficulty is the problem of costs of publishing books today. The technical book by its very nature is much more costly than, for example, a novel, but all costs of book production have risen nearly 100 per cent in the past few years, and were it not for the greater demand for technical books since the war, their selling prices would have to be even higher than they are today. The publishers are making every effort to reduce costs.

Several new and highly original methods of book composition are now in process of development. One in particular in an experimental stage is being partly financed by the publishing houses. It is to be hoped that these methods will result in the reduction of costs and consequently of the selling prices of books.

In conclusion, I would like to say that I am sure that the engineering and scientific publishers are conscious of their responsibilities to the world of engineering and science. In preserving and in sharing technical knowledge, we can promote the kind of intellectual cooperation between scientists and engineers that is so necessary to the full development of the Pan-American world. All of us have much to gain from this development. We shall not only benefit our individual countries but we shall also help largely to make the entire free world one which sees peace and the well-being of all people as its ultimate goal.

Value Judgments in Professional Education[1]

By ROBERT E. DOHERTY

President of Carnegie Institute of Technology

Education for the professions has been trying to catch up with the growing demands of the times. It has of course made seven-league progress from the days when the "curriculum" for would-be doctors and lawyers was an office apprenticeship with reading and janitorial duties, and for engineers merely an apprenticeship in the shop or field and the drafting room. But along with the progress in professional education has come even faster changes in the social structure, spurred on by new developments in science and technology. The speed of these developments has been so bewildering that one has even heard serious proposals for a moratorium on science and technology! The demands of the times have always kept ahead of education in the professions, and they are far ahead now.

One responsibility that no profession has adequately coped with has now assumed frightening importance. To what ends will professional men direct their energies and abilities? In our democratic country, where the people handle their own affairs, an intelligent answer to this question is mandatory, and the answer turns on a sense of values, especially the values by which professional men live and work. In view of atomic energy the question may, at the moment and on the surface, appear especially urgent in engineering and science; but this new development has merely thrown the spotlight on one side of a general problem which affects all professional education fundamentally. And I wish to urge attention to this general problem.

Fundamental Pattern of National Life Depends Upon Value Judgments

Let me begin by stating a general thesis from which my thoughts regarding this particular matter stem. Under the American system, professional men largely set the fundamental pattern of national life. The character of that pattern depends not alone upon their technical ability, nor yet upon whatever ability they may have in dealing with human and social situations; it also depends—depends critically—upon their attitudes, upon the way they look at things. These attitudes have some of their principal roots in value judgments; and these judgments, in turn, depend critically—or perhaps I should say *can* depend critically—upon education. Therefore any program for the development of a professional man, must recognize this fact or else fall far short of what I believe is now required for an enduring America. In other words, the ends toward which abilities are used are just as important in determining the outcome in national life and individual life as the abilities themselves, and those ends are determined when values are adopted. Hence recognition of the critical role of value judgments and therefore of the importance of cultivating intelligent procedure in arriving at them are educational "musts" of the first order. And it is these I wish to discuss.

I hope I may assume that the general thesis I have stated needs little elaboration, although perhaps I should discuss

[1] Address given at dedication exercises at the University of Illinois.

some parts of it. A word of definition may be in order. It may be asked, what is meant by "professional men" in the sense I have used it. I refer to men whose practice involves—or should involve—the application of a body of higher learning: lawyers, engineers, physicians, ministers, businessmen, industrial leaders, etc. I may be close to the fringe when I include business and industrial leaders. But certainly these fields are at least semiprofessional now and are on the road to becoming truly professional. And if among industrial leaders I include top-level labor leaders, as I do, I may be accused of being out of bounds. I can only say that if they are not professional men, they should be, because their responsibilities are professional in character; and as time goes on I believe that such leaders as are not must ultimately be replaced by men who are. All of these components constitute the group I have called professional men, who by the decisions they make day-by-day, year-by-year, determine local and national trends, and thus the pattern of national life.

I have said that the character of the pattern of national life depends not only upon the ability but also upon the attitude of professional men. A member of any practicing profession deals with practical situations that involve, whether he recognizes them or not, human and social elements as well as technical. The ability to understand and cope with all these elements to a degree commensurate with their importance in the situation, and the ability to point the solution toward proper ends, must, I assume, be taken for granted. But to develop these abilities involves extremely difficult educational problems—much more difficult than they are generally thought to be, even by many educators themselves, especially those who have not tried to do so. For these problems are not solved by telling the students what we know; they involve the development of analytical and creative ability, and also the cultivation of an intelligent attitude which will determine in a large measure the ends toward which such abilities will be directed.

There is another point about the general thesis. In urging the importance of values as a foundation of attitude, I need not dwell upon its other foundations. Certainly, family climate and traditions, including religious and political affiliations, and also the school program and the moors in which one is reared before college, all weigh heavily in one's attitudes, and in professional men all the more so in the degree to which formal attention to values is omitted from college education. The earlier influences become dominant in the absence of the other.

By and large the evidence is that the freshman enters college with little or no recognition or understanding, let alone appreciation, of the values he has adopted, willy-nilly, or of the other factors I have mentioned which together with values determine his attitudes. Moreover, there is ample evidence within my own observation and experience that in engineering when the student graduates from college, his recognition or understanding of the role of values in his life is little, if any, better than it was when he entered. Indeed, outside of the ministry, I have seen little evidence that the other professions are any better off in this respect than engineering. Hence I say again that to the extent that attention to values is omitted in college, to that extent the unidentified traditions and mores take over; they become a decisive part of the individual and determine his attitudes. And of course they remain so unless later intellectual, emotional, or other forces modify them. Don't misunderstand. I am not saying these unidentified values are not good. They may be. I am saying that they have been accepted without critical examination, that they are used unconsciously as a basis for decision, and that this is not good.

Moral and Spiritual Values Needed as Basis of Judgment

I have paused long enough to remind you of these other evident foundations of attitude so as to help us focus more sharply upon the critical role in professional education and practice of value judgments intelligently arrived at. Let us now consider this role.

It is twofold. The first role I have already mentioned: such judgments determine in part—or can so determine—the professional man's attitudes and thus the ends toward which his activities are directed both in his professional practice and in his life as a citizen and as an individual. Let me illustrate. The practicing engineer, in making decisions that confront him, must settle in his own mind, whether consciously or unconsciously, what relative weight he will assign to such values as personal advantage when this is placed alongside the values of ethical professional behavior; what relative weight he will assign to efficiency of labor-saving devices when this is placed alongside human and social welfare; to safety when this is placed alongside cost. And this engineer, as citizen, must likewise determine—again whether intelligently or by "hunch"—what relative weights he will assign to the value of his own time and personal convenience, on the one hand, and to the value of his service, as an educated man, to his community and to his country, on the other. He must likewise decide, as a citizen, as between the value of human freedom and the American way of life, with its attendant costs *to him* in money, time, and personal attention, and the values, as he may see them, of living under other forms of organized society. And as an individual, before he can live an intelligently directed and emotionally stabilized and satisfying life, he must adopt a set of moral and spiritual values as a basis of judging what is good and what is evil, and where his faith should lie; and a set of artistic and literary values for appraising and appreciating the great works in these realms. In other words, to achieve a well-ordered life that is rewarding in all of the activities of a professional man in his full stature, he must achieve a hierarchy of values, practically consistent, that will determine the ends toward which he will live and work: in short, a philosophy of life.

The second role of value judgments is related to the first: they constitute a logical basis for thinking. In the human and social realm such judgments are, *in this respect,* the counterpart of physical laws in the realm of science and engineering. They form the same kind of basis for constructive thinking—for analytical and creative ability. The primary difference is that physical laws are, of course, for all practical purposes, fixed, are not subject to opinion and choice; whereas value judgments are not fixed in the same sense, are subject to opinion and choice. Also, of course, one recognizes the intrinsic difference between a physical law and a value—that is, between a cause-and-effect relationship, on the one hand, and a chosen end, on the other. But in both realms intelligent thinking, whether the purpose is to understand or to determine what to do in a practical situation, must proceed from a logical base. For example, to determine how to go about a problem involving energy transfer, one of course falls back upon the Law of Conservation of Energy. Or, taking a case in the other realm, to decide what to do, as a citizen, about the problem of low-cost housing, one must look to his own values as the starting point in reaching his decision. Thus, there must be a foundation for intelligent thinking in either realm, and in the human and social realm where ends are so important, the values that are adopted by the individual form an essential part of that foundation.

Stages in Achievement of Intellectual Competence

If the point of view I have proposed regarding the essential role of values is

accepted, we may now consider what this implies in professional education.

Let me again turn to a general concept as a setting in which we may explore this question. It is a concept which, for good or ill, I hold after struggling with the problem of education for over twenty-five years. My observations have indicated that in the achievement of intellectual competence and maturity there are three stages. I do not mean that every student who achieves such competence passes these stages in succession; I do mean that among graduates (and of course among students) one can recognize such different stages of attainment —perhaps in different degrees in the same individual. Thus, the concept represents merely a convenient scheme of classification and definition.

The first stage—if I may indulge in radio parlance—is what I would call "quiz-kid" learning. One learns facts—merely facts. Such learning can hardly be called encyclopedic, because in the encyclopedia the facts are at least ordered alphabetically! I refer to the welter of miscellaneous unrelated facts and information that today, I am afraid, characterizes too much of the learning in both secondary and higher education. It is the kind a student memorizes from lecture, class, or study, and passes back to the instructor in a quiz.

The second stage is the organization of knowledge. This is the selecting and pulling together of related facts and information. But it is not merely this; it involves also another selection. After selecting facts and information that are *related,* one must then select from these the items that are *significantly related;* that is, those groups of related items that can be fitted together into an organized whole. This twofold discrimination, together with the organizing process itself is the way facts and information become useful knowledge.

One may picture this process. When such a new fact or idea is grasped by the student, he will, with the guidance of the instructor if he needs this, relate it to his existing knowledge by adding it, articulating it, to his growing tree of knowledge. If it is of fundamental significance, it may belong as part of the trunk, or even be a new root. One thinks of the roots as fundamental generalizations—for example, natural laws, economic generalizations, basic moral and political values. One thinks of the trunk as including corollaries and other derivatives of the basic generalizations, and also fundamental data that make these generalizations meaningful—for example, the space-time relationships that follow from Newton's Laws of Motion, the systems of units and the constants that go with them, the form of social organization that best fits the political values one has adopted and historical illustrations that support that form, and so on. And one thinks of the branches and foliage as further extensions of specialized learning—for example, a formula for a specific case, or a new variation in electric motor design, or a new court interpretation of the Taft-Hartley Law, or a new illustration of human fortitude. Such a body of knowledge, so organized, represents a master *gestalt*—if I may borrow a word from psychology—in terms of which further learning becomes both intelligent and interesting. And the achievement of such a gestalt represents what I have called the second stage.

Something further may be said about this second stage. Certainly it constitutes one of the legitimate aims of higher education in any field. If limited within the definition I have suggested, its end result for the student is at least the ability intelligently to understand and to think *about* what he has learned, and perhaps a basis for inspiration and personal satisfaction. However, if education is limited to these terminal results, it cultivates merely what I would call a "scholarly front"—an ability to talk and write in an interesting and impressive way *about* what one knows. But there remains a great gap. One has not learned how to struggle with the situations of life; he can think and talk about them, but he

cannot *do* anything about them; he has not cultivated an analytical and creative ability.

The achievement of this additional and higher ability represents the third stage of competence. It is the disciplined ability to analyze and the creative ability to devise means to an end.

Professional education may therefore be defined in terms of this "three-stage" concept. Its aim should be the achievement by the student of the second and third stages: which is to say the achievement of a foundation for his further learning and progress, so that after graduation he can continue to grow to his full stature as a professional man, citizen, and individual.

But our primary concern here is how to help the student achieve the second and third stages in connection with values. How can we help him learn to discriminate among values and to arrive at intelligent judgments? How can we best guide him to an effort to relate these value judgments to each other? How can we help him to learn how to use them as a basis for deciding what to do in practical situations?

Approach in Teaching Professional Judgment

Let me say at once that certainly I am in no position to give you the full answers to these questions. I do believe, however, that I am in position to define the general problem of the role of values in professional education, and I have done so. And I believe too that I can state a basis for the solution, and it is this I shall now try to do.

My own observation and experience have convinced me that the best way for a student to learn how to do something is to do it. This may require many attempts, if necessary under guidance, learning something further from each experience, until he can do it. Moreover, psychologists tell me that this makes sense. And this applies as much to the process of reaching intelligent decisions about values as it does to reaching intelligent decisions about anything else. If this view is accepted, then we at least know how to begin.

The first clear inference from this principle is negative. The student does not learn how to do such things merely by having someone tell him how or having someone do them for him. He must *do* them himself.

If we want him to learn how to discriminate among values and make intelligent judgments, we must give him the opportunity to face alternative values—confront him with what John Dewey calls a "forked-road situation." Thus confronted, how does the student make up his mind which way to go? Certainly not by being told which is the best way, for only he can decide which is *for him* the best way. Such a judgment is, or should be, a personal matter. Certainly not by having him choose merely on the basis of his family traditions and the provincial mores in which he was reared, nor on the basis of what he has read in the newspaper. If he is to decide intelligently, as we must insist that he do, then he must first learn how to do something else before trying to decide: he must learn how to select, organize, and use evidence.

This is a discipline of history, and at least one way of helping him to learn it is, for example, to have him take a course in history that is *pointed to this end*—that is, one in which cases are carefully selected with respect to their usefulness in the student's effort to learn how to deal with evidence. Needless to say in passing, this is not the traditional undergraduate course in history. Thus can he learn to infer from the written record, generalizations about nontechnical matters, including values.

History is not, of course, the only source from which to appraise values; one may not even consider it to be the most important source. Other subjects of study and one's personal experience may be as important, or more so. Neither is it the only source for learning how to generalize from evidence, because there

are other kinds of evidence. For instance, the engineering student learns to generalize—or should learn to—from dealing with quantitative data in the laboratory. But history's unique place in the problem we are considering stems from the fact that its primary discipline is the constructive use of evidence *from the written record.* And the student must learn such use before he is in position to make intelligent value judgments from evidence in such records.

Thus can he get a start at learning how to separate out relevant items of evidence, organize them into a meaningful relationship, and draw a generalization. And even while he is learning how to go about this process of creative analysis, the student will presumably deal with at least some cases that involve values; and later and broader study, if properly directed, will both sharpen his skill and bring him increasingly to the point of making value judgments that are intelligent, even if, at this stage, they are still tentative.

They must of course be tentative at first, because as time goes on the student may realize that a value he adopted earlier is in conflict with one he now sees reason to adopt. In that case, a new study and revision are necessary, since naturally the whole set of values he ultimately adopts must be practically consistent. By such a process the student can get a start in gradually approaching a hierarchy of values that are in a practical sense mutually consistent, and thus achieve in this realm of values what I have referred to as the second stage.

Value Judgments as a Basic Analytical Ingredient

We now come to the question how to help the student learn to think constructively in terms of such values. This involves precisely the same educational problem as helping him to learn how to think constructively in terms of any other general principle, for an adopted value is a principle. And if the educational approach I have proposed is accepted, the teaching method is clearly indicated: confront him with a practical situation the solution of which involves values, and require him to make an intelligent, well-ordered decision what to do in the situation and to justify that decision.

Every time he struggles through such a situation *in this way*, he has learned the better how to tackle the next one. And as he approaches intellectual maturity, he will come to think in terms of his adopted fundamental values as a matter of habit. In other words, he will have achieved an intelligent, professional attitude that will determine to what ends he will direct his energies and abilities. It will be a constructive attitude that impels him to take a position on important issues of policy, and not, through ignorance or lack of intellectual moorings and therefore of self-confidence, to retreat to a neutral corner as engineers are so likely to do; or worse still, to take an active position on the basis of "hunch" or opportunism.

But one may ask, What if such an education leads him to take the wrong position? This question is important, because it is frequently asked and thus demonstrates a confusion of the very thing we are discussing—namely, fundamental values. And when carried into educational policy, this anxious point of view represents the worst kind of aberration. To ask the question implies a lack of confidence in intelligent procedure, and disavowal of intellectual freedom, or a misconception of what I mean by values. It urges partisan indoctrination on one count and the "iron curtain" on all alternatives. As an example, it would urge that we indoctrinate students with Democracy but not mention anything about other ideologies. Such proposals are bad not only for the reasons just given; they are bad also because they are educationally ineffective. In the first place, an intelligent student easily detects an attempt to indoctrinate him, and his respect and confidence are thus lost. Worse still, even if the stu-

dent could be cultivated in such an intellectual greenhouse protected from every challenge of worldly weather, what will protect him when he leaves the greenhouse and must face the challenge of the outside world? If he merely accepts what persuasive teachers say, then he will presumably keep on learning the same way after he graduates. Having no deep-rooted convictions born of struggle, he is more likely to be easily swayed by the propaganda winds of the day.

What is needed in America is intellectual toughness, born of intellectual struggle, and resting upon a foundation of values built during that struggle. I have no fear of the conclusions which professional men, thus educated, would reach, for I have full confidence in intelligent procedure and place top value upon intellectual freedom. What I do fear is a teacher or an administration that insists on telling the student, in a partisan spirit, what the answers are—or what the teacher thinks they are. What is needed throughout higher education, as I view it, is more teachers and administrations that will insist on students achieving the second and especially the third stages of competence in regard to values, and will take the time and have the patience to solve the extremely difficult educational problem that is involved. For it is very far from being solved today.

But the stakes are high. The development of a new breed of professional men who not only can perform effectively in the technical part of their work, as they can now do, but also serve the additional functions I have outlined, may be a very important factor in the endurance of America. Leading educators in the professional schools of the country are today groping toward a new educational policy that would train their graduates to carry a responsibility now largely neglected—that is, to deal with the human and social factors in their professional problems.[2] But I am proposing that a further aim, as yet scarcely touched, be added—namely, a start toward the development of a set of values that will determine the attitude of the graduate—the ends toward which he will work and live as a professional man in his full stature, as a citizen, and as an individual.

[2] Education for Professional Responsibility (Proceedings of Inter-Professions Conference on this subject held at Buck Hill Falls, Pennsylvania, April, 1948), Carnegie Press, Pittsburgh.

College Notes

Dr. Ju Chin Chu, one of the younger chemical engineers to gain an international reputation in his field, has joined the faculty of the **Polytechnic Institute of Brooklyn** as an associate professor in the Department of Chemical Engineering. Since 1946 when he took his degree of Doctor of Science in Chemical Engineering at the Massachusetts Institute of Technology, Dr. Chu has been director of research in the Department of Chemical Engineering at Washington University, St. Louis, Missouri.

Paul P. Ewald, renowned pioneer of X-ray crystallography, from Belfast, Ireland, will assume the chair of Physics at the **Polytechnic Institute of Brooklyn.** As the new head of the Department of Physics, Dr. Ewald, who is the editor of *Acta Crystallographica,* the international journal in the field of crystallography, plans to return to experimental work in the field of X-ray diffraction and in other fields covering the physics of the solid state.

Faculty Personnel Factors and Promotions*

By JOSEPH WEIL

Dean, College of Engineering, University of Florida

In the kaleidoscopic pattern of college activities of sports, physical education, military training, social and professional fraternity demands, glee clubs, debate societies, bands, orchestras, college politics, and social events there must still be found time for lectures, laboratory work, and study. This must be done even though the student is required to secure employment to help defray his expenses and even if the married student finds his domestic problems encroaching upon scholastic activities.

But out of the total time available of 168 hours a week, a college professor is seldom able to see a student more than from 12 to 24 hours. If the professor is to serve as efficiently as the football coach, the faculty advisor of the fraternity, or the director of the glee club, he must use the few hours available to him effectively. If he does not, then, the student, in the face of the heavy demands on his time and not having sufficient time for sleep, will use the classroom for this purpose.

Selection of Faculty

The administration of the University should endeavor to select the professional staff with as great care as it does its other personnel. If the college is to attract the young men of the state, not only must there be a winning football team, an outstanding band, a beautiful campus, but also the "catalog" should portray the opportunities for study. Today, I fear, most college information pamphlets depict the beauties of the campus, the size and number of the buildings, the comfort of the dormitories, the opportunities for recreation, but they do not, at least in some cases, give adequate information about the staff.

Does this mean that the selection of the staff is not given careful consideration? Certainly nothing could be further from the truth. It does mean, I believe, that in the scramble for recognition, often in order to secure more students or larger appropriations, certain factors are played up prominently. Those faculty members who then assist in the growth of these public interest factors may then appear to reap benefits, while their colleagues busy with teaching or research are passed by.

Certain vocations such as the ministry and teaching are selected by individuals because of some inner feeling that they have what might be considered a calling for service to the public. Neither the teacher nor the preacher follows his vocation because of his desire for pecuniary gain or because he desires the plaudits of the crowd. Yet, I doubt whether there is anyone who does not desire to secure some recognition for outstanding accomplishment in his chosen field of endeavor. In the case of the teacher this recognition may take various forms. It may come in the form of satisfaction resulting from the gratitude of students who appreciate the efforts of a good teacher. It may come in the form of the gratification that a teacher secures in observing the rise to fame of successful graduates. Anyone could add many other forms of

* Presented at the meeting of the Southeastern Section of the A.S.E.E., University of South Carolina, April 7, 1949.

compensation which come to the conscientious teacher. It might be said that the amount of real satisfaction which comes as a result of his vocation will, in practically every case, be dependent upon the individual's successful performance in his profession. While many more or less intangible factors may be mentioned as a measure of success, most educators today desire—in fact, also require—more tangible and practical evidence in order to enable them to continue in their work. I refer particularly to financial remuneration. There is considerable feeling among many educators that this tangible evidence of success is not always as fairly allocated to individuals as are the more intangible factors. It is the purpose of my talk today to give from the administrator's viewpoint a picture of what personnel factors are considered important and which are taken into consideration by at least some administrators in the adjustment of salaries.

Factors to Consider

A conscientious administrator always endeavors to balance human aspects with practical administrative requirements in attempting to be as just as is humanly possible. It is but natural that he would like to give consideration to such matters as the size of an individual's family, any special financial difficulties which have arisen, and other matters which in no way can be considered as determinants pertaining to effective teaching. But the administrator is a liaison agent between the individual faculty members and higher administrative groups. He must be ready to justify every increase that he recommends. He must be able to explain any apparent differences in salaries between individuals doing approximately the same work. The administrator in an engineering school necessarily endeavors to find some means of measurement in order to be able to more accurately perform his task. He tries to synthesize the problem and then to apply measuring devices to the various elements. He takes cognizance of the fact that he is dealing not with material objects but with human beings with their infinite variations. He recognizes quickly that no measurements can be considered as accurate but must at best be an approximation to be used as a guide. Since I cannot speak authoritatively for any college other than my own, I shall endeavor to give the philosophy which has governed our policies pertaining to advancements and salary increases in the College of Engineering at the University of Florida. We know that what we have done is but the beginning of our efforts to bring forth a system which can be considered as equitable in making judgments of merit.

One policy which has been adopted has been to endeavor to base individual promotions and increases in salary upon an evaluation of the individual's qualifications. The mere fact that a person has a particular title or some special assignments is not by itself considered as a sufficient reason for a salary increase. An outstanding teacher may be worth more than a mediocre administrative officer. Salaries should be commensurate with individual worth. One should not have to do administrative work to secure the top salary.

It has not been our policy to attempt to meet offers which individuals might receive from elsewhere. This places a responsibility upon the administration to take steps that merited individuals receive salary increases commensurate with those they may later receive from elsewhere. When this cannot be done, other compensations should be brought forth in order to equalize the over-all compensation.

Faculty Evaluation

In order to determine what promotions and salary increases are to be recommended, meetings are held of the department heads of the College. All individuals, except those present, are then brought up for discussion and attempts are made to analyze them. A

large number of criteria are considered, which are listed here:

physical qualifications
intellectual qualifications
emotional qualifications
volitional qualifications

including morality, health, vitality, vigor, enthusiasm, integrity, honesty, cooperativeness, resourcefulness, appearance, and others

education
experience
teaching proficiency
membership and activity in professional societies
professional registration
other professional activities
value as a member of committees
research activities
student contacts
contacts with general public
general stability
years of service
honors

In attempting to grade these a seven letter system is used:

A—Outstanding
B—Good
C—Average
D—Low
E—Poor
U—Unsatisfactory
X—Not rated—not sufficiently well known

Let me say here that it is not intended to average these grades and so produce an over-all or weighted average. The various factors should not have similar weights for all classes of work. Considerable variation should occur in evaluating a young instructor and one of his mature colleagues. At best this analysis merely gives a sort of general picture upon the cross-section opinion of several persons who are in a reasonably good position to have accurate knowledge of the individual's qualifications.

The factors that have been mentioned above might be partially offset by a group of negative factors such as the following:

inability to express oneself properly
failure to be punctual
lack of cooperation
disgruntled or objectional personality
a trouble-maker
careless of safety conditions
too impatient
unavailability—not on the job
lack of judgment
poor health
unthoughtfulness or untactfulness

What Constitutes a Good Teacher?

Some men believe that they are exceptionally good teachers. They base this upon the fact that they are hard taskmasters; that they give out class assignments in a methodical manner; that they hold their classroom work on an assigned subject and permit no departure from it; that they demand a great deal of work from the student and that they grade it and return it to him. But while all these things are important, they, by themselves, do not make an outstanding teacher. Sometimes variations from such a routine procedure may be of real value from a pedagogical standpoint. A stimulating and sympathetic teacher, one who inspires his students to amass a large fund of knowledge, is a rarity and when he is found he should be compensated accordingly.

The amount of importance that can be attached to a particular rating on the rating sheet varies greatly for various persons. Some persons must help with administrative duties. It is this group who should be given added credit for the effectiveness of their contacts with students, with other members of the staff, and with the public. Research personnel need not necessarily be good teachers, although many of them are. All teachers need not do research. Certain traits, however, should be common to all of the professional staff of an educational institution.

Without attempting to arrange the factors discussed above in any particular order, lists were distributed among the faculty of the College of Engineering at the University of Florida. It was suggested that each member classify the factors enumerated into categories of relative importance. As a result of this the following factors were selected in order of importance:

teaching proficiency
experience
education

Then, but given less weight, came:

research activities
cooperation
general stability
student contacts and inspiration

Then, but considered of still lower importance, came these factors:

professional activities and contacts
public contacts
society membership
registration
committee value
years of service
honors

It must be considered that these evaluations are the opinion of faculty staff members and not administrative officials. It is of interest that evaluations secured from persons employed primarily as research workers differed little from those secured from the teaching group. The chief variations occurred as variations of items in a particular grouping. Research workers and teachers would necessarily interchange the top items in the first two groups.

Viewpoint of the Administrator

The administrative officer in evaluating some individuals would give added importance to such items as cooperation, student contacts and committee value. Yet every faculty member should not be called upon to do a large amount of administrative work. But since administrative work must be done, credit should be given to those individuals who share in it. While it is true that the basic objectives of a college must be the dissemination of learning and the advancement of knowledge, only about 40% of college expense is allocated to salaries for teachers and research workers. Those who help in the wise expenditures of the remaining 60% of the school's finances should be given credit for their assistance. Any person interested in college operations is well aware of the numerous administrative tasks that are required for efficient operation. Curriculum building, student counselling, committee work of varied types- all are necessary. The efficient operation of any university depends on these matters and teaching and experimentation cannot be effectively done without them. Those who do such work render services which should be recognized.

At the University of Minnesota it was found that for the period of 1913 to 1931 factors entering into promotions were of the order of importance given in column 1.*

	%	%
teaching	43.4	35.4
productive scholarship	27.6	22.9
student counselling	11.6	7.1
administrative work	11.0	9.9
public service	6.4	5.1

The second column gives the information for Indiana University.

The evaluation of the criteria considered will necessarily vary greatly, not only for different institutions, but even for different groups within any particular institution. Of importance in any study such as this is the fact that it gives to the individual faculty member a picture of an administrator who does not sit down arbitrarily to make promotions or to allot salary increases, but it gives him a chance to see what factors are taken into consideration. Furthermore when his rating sheet is considered by a member of the faculty, in many cases, his first action is to have him interrogate himself.

* AAUP, Vol. XXVII, Oct. 1941, p. 446.

Thus under "education" he asks what further studies shall I undertake. Here is an answer to whether or not it may pay to study for an advanced degree. Under "teaching proficiency" he may consider what he can do to improve his pedagogical methods. Thus, he may prepare himself more thoroughly for his classes. Since "research activities" are to be considered, here is an incentive to work on that problem that has always been so intriguing. Here, too, is a reason for joining and taking an active part in professional society work. One might even ask, "Can I afford not to belong to these professional societies if the salary is partially dependent on it?"

The equation for success contains many unknowns. As we accurately delineate these unknowns, our chances for success are greater.

It is my belief that the study of the rating sheet has resulted in stimulating staff members to activities that have been worthwhile. It has enabled them to better understand the problem of the administrative officer and has resulted in greater harmony. In the truly democratic way it gives the faculty member a chance to discuss his position with his department head. He, in turn, fortified by the composite opinion of a group can assist the staff member in materially improving himself.

Division Forum

Industrial Engineering

With the turn of the century we find a new area of thinking permeating the field of engineering instruction. One engineering school as early as 1908 introduced a curriculum and a department of Industrial Engineering. Since that time the growth of these departments has been a steady one. The 1940's reflect an accelerated recognition of the place of Industrial Engineering in the overall engineering program of colleges and universities.

To the end that those schools with Industrial Engineering Departments or organized options in other curricula can strengthen programs and to give guidance to those schools laying plans for development of this area of instruction, the A.S.E.E. Industrial Engineering Division is planning a program for the Annual Meeting at Seattle which should be thought-provoking and most profitable. Those attending the Troy meetings will recall the stimulating discussion of "What Is Industrial Engineering?" With that introduction the program at Seattle will continue with knock-down panel discussions of such topics as:

A. *The Industrial Engineering Curriculum:*

1. Basic engineering core courses.
2. Industrial Engineering core courses.
3. Other courses.

B. *The Graduate Program in Industrial Engineering.*

C. *Who Should Study Industrial Engineering?*

That these topics will generate lively and heated discussion goes without saying. With panels of experts for each topic and with many others attending who have given these subjects real individual thought, the Industrial Engineering Seattle meetings should be memorable ones. Don't miss them!

EDITOR.—*A page in each issue of the* JOURNAL *will be devoted to constructive comments from the various Divisions of the Society. Manuscripts should not exceed 500 words in length and should be sent by the Division officers to the Secretary of the A.S.E.E.*

Federal Scholarships and Fellowships for Selected Engineering Students

By WALTER E. BLESSEY
Associate Professor of Civil Engineering

Introduction

Our whole system of higher education in the United States is reaching far too few persons with a program that is too low in quality. Certainly all of the land grant colleges need to intensify and broaden their work. To keep democracy in this country we must have enough minds that have been equipped to think broadly, deeply, and clearly. Instead of having 4 per cent of our population college graduates we should raise the percentage to at least 10 per cent.

In a study of higher education for the House of Representatives, 78th Congress in January 1945 it was found by questionnaires that almost all colleges and universities favor federal aid to students in the form either of direct scholarships or work aid, comparable to the student aid program of the National Youth Administration, in most all instances preferring scholarships. Federal competitive scholarships are strongly recommended by college and university administrators as one of the most important single means of equalizing educational opportunities and of aiding institutions of higher education. The committee making this study reported that the need and opportunity for research work in a very large variety of fields was of such magnitude and general recognition that it highly recommended federal assistance for such work.

History of Federal Aid to Higher Education

The federal government, beginning with the Ordinance of 1787 and through a long series of legislative acts, has continually encouraged and assisted institutions of higher learning. In so doing it has aided them in extending their activities and increasing their services over a wide field.

The methods through which such assistance has been given may be grouped as follows:

1. Grants for the founding and early maintenance of several private colleges.
2. Grants to states for land-grant colleges and state universities, both for general use and for the development and operation of agricultural experiment stations.
3. Grants for specific institutions: The United States Military Academy, the United States Naval Academy, Howard University and others; also for the education of the Indians.
4. Payment to both public and private institutions for specific services, both continuous and for the recent war emergency: agricultural extension; training of war workers in engineering, science and management; R.O.T.C.; Civilian pilot training; Army and Navy college training programs; and research.
5. Scholarships and student aid in various forms for students enrolled in both privately and publicly controlled colleges and universities; the college work program of the N.Y.A.; the rehabilitation of disabled veterans under Public Law 16, 78th Congress and of civilians disabled in war industry and otherwise (Public Law 113); and since June 1944, education of veterans under Public Law 346 (The G. I. Bill), 78th Congress; the nurses train-

ing program of the Public Health Service; and the scholarships granted through the Department of Commerce for students to study meteorology.

6. Funds for refinancing through the Reconstruction Finance Corporation and for construction under the Public Works Administration, available only to publicly controlled educational institutions.

There is no consistent pattern running through these federal legislative acts but it is evident that the Federal Government has made and is making use of higher educational institutions.

Necessity for a Program

The object of a federal scholarship and fellowship program is to discover and develop scientific talent particularly in American Youth, thereby promoting the development of science and technology. No research program could operate effectively for long without that talent. The one greatest risk in the democratic educational system maintained in this country is its danger of bringing about too great uniformity on the level of mediocrity. Democracy, more even than other forms of political organization, demands that each individual be stimulated as far as possible to rise to his highest level of ability. If young people of superior capacity are taught in mass production methods of education and fail to put forth their best effort they will not achieve their best development. Society will thus be deprived of the contributions they should have been prepared to make.

The schools, colleges, and universities everywhere are striving to cope with this difficulty in our democratic system of education. They are meeting with greater and greater success each generation in overcoming the problems of educating all children in a common school system. But they will be assisted greatly if the Federal Government establishes a program of scholarships and fellowships designed to encourage the further education of young people of exceptional talent. Such encouragement will include grants to help retain in college and university talented young people who would not otherwise continue. But it will also include nonmonetary recognition of talented young people who do not need the money. In fact, the greater significance of a program of scholarships and fellowships lies in the the psychological effect of the Government's putting its stamps of approval on the efforts of educators to identify and develop to the highest level young people of superior ability. This program is, therefore, not only intrinsically important from the standpoint of stimulating research, but it is at the very center of the efforts to gear up the educational system of the country. It must not be regarded as significant alone because it will assure an adequate flow of competent personnel to work on the research projects, important though that is. Its significance is far greater in that it is bound to improve the standards of all American education.

The question may be raised as to whether under present arrangements practically all of the most competent young people do not already complete high school and enter college. A good many studies have been made of that question. Some of these have been State-wide. Every study reveals essentially the same facts, namely, that for every young person standing in the upper quarter of his high school class in achievement who goes on to college, another young person of equal achievement does not go on to college. Similarly, those dropping out of high school before they graduate include many of the most able young people. Army classification tests as related i *Science* by Psychologist Adjutant Gen eral W. V. Bingham showed that among 105,000 men who made the top third on the tests over 2000 had never been beyond the eighth grade (some much less) and nearly 8000 had only one to three years high school.

There are many reasons for this, but two are perhaps most dominant:

a. The most able young people are the ones who are in greatest demand by employers.

b. The other reason is a financial one. They dislike to be a further financial burden upon their families. Sometimes the parents are quite unable to help them with their college expenses no matter how much they would like to do so. In such circumstances young people of ability (and they are frequently also of high sensitivity) do not think it appropriate to go on with college.

A few decades ago students could enter college and make their own expenses easily. It is much more difficult for them to do so today. Tuition fees and living costs are higher than they used to be. Opportunities to work one's way through college are less common in proportion to the number of college students than they once were. Hence young people without means tend not to enter college or, once having entered, tend to drop out.

It must not be concluded from the above, however, that the sole purpose of the scholarship program is financial aid. The honor attached to selection will be an incentive to a large number of young people who not only do not need the money but might even be harmed by it.

The Scholarship Program

Scholarships should be of at least two types, including honor scholarships without stipends and honor scholarships with stipends. These stipends should vary according to the financial needs of the students. There are strong arguments for including also honor scholarships providing stipends for full or partial service called work scholarships, and honor scholarships entitling the student to a loan. These various types are necessary in order that the scholarship program shall fit in properly with the prevailing practices on the various college and university campuses.

In order that the system of scholarships shall accomplish this purpose, the following must characterize its operation:

a. Some of the awards must be made not later than the time young people graduate from the high school. Only thus can the superior young people be stimulated to enter college.

b. Some awards must be available to students already attending the several types of colleges and pursuing courses in any field of study. High native ability is not limited to students attending any particular type of institution nor to those studying any particular subjects. Furthermore because of the variety of organizations prevailing in institutions of higher learning, the scholarships should not be rigidly limited to undergraduate schools.

c. The awards must be based upon criteria recognized by the young people themselves as effective in identifying unusual competence. These criteria will no doubt include examinations designed to test native ability, evaluations by teachers and others who know the young people, and grades obtained in high school and college.

d. The area covered by the scholarship competition must be large enough to make the award carry a distinct honor. It is believed, therefore, that the competitive area will need to be as large as a State.

e. Scholars should be authorized to attend any approved institution of their choice.

To accomplish the basic purposes of the scholarship program the form of administration most effective should be as follows:

The unit of administration should be the State. A scholarship board representative of the State department of education, the high schools, colleges, and universities should be set up by the legislature in each State. This board should select the young people to whom scholarship awards of the various types are to be made, and be responsible for carrying out the program. The scholarship certificates should, however, be issued by the Washington office, endorsed by the appropriate officer of the State or city scholarship board. In this way it would carry in the mind of the recipient the highest possible recognition.

The Fellowship Program

The fellowship program has as its principal purpose the encouragement of the more mature talented students to continue their studies. These men and women, usually college graduates and often well advanced in their special fields, are competent to render technical and scientific help on research projects. They are usually prepared to fill positions in the community of considerable responsibility and at reasonably good pay. In some cases, they are so determined to go further with their education that they will do so regardless of the sacrifices entailed. In other cases they yield to the natural impulse to accept employment. In either circumstance a fellowship will be helpful. In the first case the fellowship will ease the strain, allow for greater concentration on the educational and research program, and enable the fellow sooner to reach his period of maximum productivity. In the case of those who have accepted employment at less than their maximum scientific effectiveness the fellowship will assure further study and research with the likelihood that the fellow will pursue a life of scholarship on a higher plane of service.

Certain it is that if the country is to have the greatest scientific (both natural and social sciences included) and technological development, every effort must be made to retain in the research program as large a proportion as possible of such young people of proven research ability. It is common knowledge that many research projects contracted for during the war could not be carried out as promptly as desired because competent research talent was not available. There are universities today which cannot accept funds offered to them for very important research projects because they have not, and cannot, recruit sufficiently competent research staffs to undertake the work.

To accomplish the principal purposes of the fellowship program, the following conditions must be met:

a. Selection as a fellow must carry with it distinct honor.

b. Stipends must be adequate to relieve the fellow from needless worry about finances.

c. The conditions for continued graduate study must be excellent and participation by the fellow in research projects must be on a high intellectual level, not on the level essentially of clerical, manual, or routine labor.

d. The number of fellows must be strictly limited to those of the highest order of ability.

To meet these conditions:

a. Awards must be made on a Nationwide basis. Selection made on a smaller area basis will not carry the honor required to appeal to the men and women of highest talent. However, those fellows who are to devote an appreciable amount of time on research projects must be selected on nomination of the directors of the research projects to which the fellows are assigned.

b. Fellows must be encouraged to study at universities where facilities of staff and equipment in the fellow's chosen field are excellent, or at research agencies which are prepared to make the research experience richly developmental for the fellow.

To administer such a fellowship program will require centralized direction with a director in the Federal office assisted by an advisory committee representing the leading university associations and research agencies. Awards should be attested by a certificate signed by a well recognized Federal official.

Reports to the President

On February 15, 1948, Mr. George F. Zook, Chairman of the President's Commission on Higher Education, reported to President Truman.

The proposals of the commission looking toward the elimination of economic status as a basis for college attendance include the establishment of an extensive

system of Federal scholarships and fellowships.

The proposed scholarship program would involve a Federal appropriation of $120,000,000 to be available for the fiscal year beginning July 1, 1948, and to increase until 1952 in such a manner as to provide financial asistance to 20 per cent of the non-veteran students enrolled in college and universities.

These funds would be allocated to the States on the two-fold bases of the number of high school graduates and the population 17-21 years of age in each State. The recipient of the scholarship or grant in aid would be free to select the institution of his choice; a State commission on scholarships would determine the amount of the scholarship granted to each individual on the basis of his financial need. The Commission proposes that the maximum allowance to any individual be $800.00 for an academic year.

In order to meet the need of selected students who wish to pursue graduate work, the Commission recommends the establishment of Federal fellowships of $1500 each. It is proposed that 10,000 such fellowships be awarded for the academic year 1948-49, 20,000 in 1949-50, and 30,000 for each of the next succeeding years. Recipients of the scholarships will be selected on the basis of national competitive examinations.

Through this program the Commission accepts the premise that:

> "Only as the opportunity for higher education is equalized for every potential student who has the interest and the ability to profit from college and university study at both undergraduate and graduate levels, can the ideals of democracy in education be realized. The program of scholarships and fellowships here proposed is not for the welfare of the individual alone but is vital in the national interest."

The commission urges a greater sense of unity between general education and specialized education. It decries the apparent breach that has been built up between education for living and education for earning a living. Colleges must find the right relationship between specialized training on the one hand aiming at a thousand different careers and the transmission of a common cultural heritage toward a common citizenship on the other.

Mr. John R. Steelman, Chairman of the President's Scientific Research Board, reported in 1947 to President Truman that a major factor in our national survival may reasonably be said to be the rapidity with which our scientific knowledge and the consequent steady improvement of our technology can be advanced.

The first indispensable resource necessary for this advancement, the report points out, is an ample supply of highly trained scientists and technicians. Today there are serious shortages in this supply.

As to the manpower shortage in science, the report concludes that our scientific strength depends neither solely upon our present supply of scientists nor upon those students now being trained. It depends ultimately upon a steady flow of able students into our colleges and universities. Most institutions are operating today at virtual capacity—thanks to the Veterans' Readjustment Act. But veterans already are beginning to exhaust their benefits; and it is clear that further steps must be taken soon, if we are to continue to improve the quality and size of our scientific manpower pool and to increase the scope of our research and development program.

Recent Bills Before Congress Affecting the Program

Two bills now before the 2nd Session of the 80th Congress affecting the program are H.R. 4852, and the Pepper Bill, S. 1131.

The most recent Science Foundation Bill is H.R. 4852 which is now before the House Committee on Interstate and Foreign Commerce. It was introduced January 6, 1948. This bill proposed to established in the executive branch of the Government an independent agency to be known as the National Science Foundation which would abolish the Office of Scientific Research and Development.

The Foundation would be authorized to do the following:

1. To foster and encourage a national policy for scientific research and scientific education.

2. To initiate and support basic scientific research by making contacts or other arrangements (including grants, loans, and other forms of assistance) for its conduct.

3. To initiate and support scientific research in connection with matters relating to the national defense by making contracts or other arrangements for its conduct.

4. To grant scholarships and graduate fellowships in the sciences.

5. To foster the interchange of scientific information among scientists in the United States and foreign countries, and

6. To correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups.

Of the five Divisions set up by the bill the Division of Scientific Personnel and Education would administer programs of the Foundation relating to the granting of scholarships and graduate fellowships in the mathematical, physical, biological, engineering and other sciences.

The Foundation would be authorized to award scholarships and graduate fellowships for scientific study or scientific work in the sciences at accredited non-profit American or foreign institutions of higher education, selected by the recipient of such aid, for such periods as the Foundation may determine. Persons shall be selected solely on the basis of ability.

The Foundation would maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States and its possessions.

The Pepper Bill S. 1131 is before the Senate Committee on Labor and Public Welfare which has held no hearings on it. It proposes: to establish scholarships and loan programs for students in the eleventh grade and above. It proposes an appropriation of $250 million to establish a revolving fund for the loan programs and provides that any interest or repayments collected shall be credited to the fund. For scholarships it proposes an appropriation of $80 million for fiscal 1948, increasing annually to $150 million for fiscal 1951 and thereafter "such sums as Congress may determine to be necessary."

Both loans and scholarships are to be apportioned among the States on the basis of a formula which takes into account the number of young people from 14 to 26 years and the per capita income.

State plans approved by the Commissioner of Education are required, including the establishment or designation of a single State educational agency as the sole agency for carrying out the State plan.

At least 10 per cent of a State's apportionment is to be expended for aid to students in the eleventh and twelfth grades, at least 30 per cent to aid undergraduate college students, and at least 20 per cent to aid students at the graduate level.

Scholarships or loans shall not exceed $125 per month for students without dependents, $150 per month for those having one dependent, and $175 a month for those having two or more dependents.

Any person may be eligible for a scholarship or loan upon application therefor approved by the State educational agency. Loans are to be represented by a promissory note to mature 20 years after the last payment to the student and to bear interest at 3 per cent per annum.

Scholarships and loans will be continued only so long as the student's work is satisfactory to the institution which he is attending, and no scholarships or loan will be made to anyone receiving educational benefits under the "G. I. Bill."

Discrimination on account of race, creed, color, sex, religion or economic status is forbidden, except that separate arrangement may be made in States which require segregation of races.

No Federal or State agency is permitted to exercise any control over personnel, administration, curriculum, or programs of instruction of institutions, or to exercise any influence upon the choice of an institution by an applicant.

Conclusion

The federal government has always been interested in aiding higher education but never with the keen interest that is now evidenced by our legislators and statesmen in the advancement of science and technology. Therefore if a federal program of scholarships and fellowships materializes, as surely it must, then, if it is to achieve its purpose, we as engineers and educators must be prepared to lend assistance to our government in the selection of the most qualified potential engineers in that vast reservoir of American high school students.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	Spring, 1950	D. M. Griffith, Bucknell University
Illinois-Indiana	Purdue University	May 13, 1950	D. S. Clark, Purdue University
Middle Atlantic	Columbia University	Dec. 3, 1949	R. T. Weil, Jr., Manhattan College
National Capital Area	Washington, D. C.	Oct. 4, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Nov. 3, 4, and 5, 1949	C. J. Posey, University of Iowa
Pacific Northwest	University of Idaho	1951	A. S. Janssen, University of Idaho
Pacific Southwest	Stanford University	Dec. 28 & 29, 1949	R. J. Smith, San Jose State College
Southeastern	Virginia Polytechnic Institute	April 20, 21, & 22, 1950	H. G. Haynes, The Citadel
Southwestern	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University
Upper New York	University of Rochester	Nov. 18–19 1949	H. W. Bibber, Union College

Constructing a Mathematics Achievement Test*

By WILLIAM C. KRATHWOHL

Director of Tests, Institute for Psychological Services, Illinois Institute of Technology

The reasons for selecting mathematics instead of some other subject to describe the construction of an achievement test are two-fold. First, methods of construction for a mathematics achievement test can be applied to many examinations given in engineering schools. Second, the methods of construction which will be described have actually been used in making several achievement tests in mathematics, physics, and chemistry. Experience with them was obtained at the Illinois Institute of Technology when the faculty had to construct achievement tests in mathematics, physics, and chemistry twice a year for the semi-annual scholarship examinations.

The first step in constructing an achievement test is to decide what is to be measured, such as information, skills, techniques, memory, and ability.

The next step is to decide whether the type of examination to be used is a subjective one or an objective one, because the techniques for constructing a subjective examination are quite different from those for constructing an objective type. For instance, an objective examination generally uses many more questions than the usual subjective examination. If an objective examination is selected, one of the various types of objective examinations must next be chosen, such as true or false, matching, completion, and multiple choice types. In the case of the scholarship examinations, the multiple choice objective type was chosen with five responses, and this is the type which will be discussed.

The third step is the collection of problems. Such a collection can be made by the author of the test as he decides what part of the subject should be known. Other members of the department involved also can be asked to submit lists of questions. Oftentimes, examinations which have been used in the past will yield good material. In any event, many more questions should be obtained than can possibly be used so that a number of examinations can be made. Later these tests can be refined, revised, and reduced in number until several good examinations emerge.

The fourth step is to decide on the length of an examination and this will depend on the time available. A rough rule for the number of questions for the multiple choice type of examination in algebra, physics, and chemistry is to allow anywhere from 6 questions per minute for a true or false type to 2 minutes per question for a difficult multiple choice type with 5 choices. These are rough approximations since the time needed for most students to complete a test depends, among other things, on the difficulty and complexity of the questions which are asked. In any case, a check on the time should be made by having some member of the department take the test and multiply his time by 2 or 3 where the examination is objective, as in this case. This is in contrast to the essay type of examination where the rule usually employed is to multiply the instructor's time by 4 or 5.

* Presented before the Division on Educational Methods at the Annual Meeting of the A.S.E.E. in Troy, New York, June 1949.

Construction of the Tests

When the group of questions has been selected for the examination, the work of the author of the test begins to get more difficult. He has two tasks to do: one is to arrange the problems in order of difficulty from easy to hard, and the other is to select the wrong answers or misleads.

The reason for arranging questions in order of difficulty from easy to hard, is to eliminate as far as possible a personality factor. There are students who have the good sense to skip a hard question and go on to the next one, but there also are students who regard a hard problem as a challenge, no matter how emphatically they have been advised to do otherwise, and who therefore spend too much time on a question which happens to be difficult for them. The result is that time is called before they have had a chance to demonstrate what they know on the easier questions. The ideal situation, which probably never occurs, is to have an examination so arranged in difficulty that a student can answer all of the questions up to a certain item which is the limit of his knowledge, and none beyond that point. The first arrangement of questions on the part of the examiner must of necessity be a matter of guess work. After that it is possible to compute the difficulty of each question for a certain type of student population and thus to improve the test for that population. Since the difficulty of a problem is, to a certain extent, a function of its situation in a test, other revisions can improve each preceding revision until the difficulty of the problem, if it varies, begins to take on some stability.

The other task, that of selecting misleads, is the more difficult one, and depends, in the beginning, very largely on judgment and experience. The task can be lightened considerably by making the fifth mislead in every question "All suggested answers are incorrect." Not only does such a choice reduce the amount of work involved from finding 4 misleads to finding 3, but it also definitely serves to improve the examination by reducing to a great degree the effect of chance in guessing the right answer; furthermore, it prevents the author of the test from making certain mistakes. If by any chance the author himself makes an error in what he intended to be the right answer, the correct answer automatically becomes No. 5. Some misleads will come from the author's own experience; others will come from experienced teachers in the department. Then too, some studies can be consulted on the way that students think, such as the findings of Keller, Shreve, and Remmers (4, 5) who made a number of reports on common errors in mathematics. There are two other methods which were used at the Illinois Institute of Technology and which yielded very fine misleads. One was to call for volunteers from the secretaries at the Institute, who had recently graduated from high school, to work the problems in the test. The other method was to issue a first edition in which the fifth mislead, "All suggested answers are incorrect," never was the right answer. A special answer sheet was used with a space to the right of this mislead in which the student was directed to write what he thought should be the right answer if he chose mislead No. 5. Some of the best misleads were obtained by this second method where a number of students gave the same incorrect answer. Excellent suggestions for compiling misleads are also given by Adkins (1), pages 56-64.

After the misleads have been chosen, a very important part of test construction is to decide in which positions to place the correct answers. In order to reduce the effect of chance and what is known as pattern marking, ⅕ of the correct answers should be choice No. 1, ⅕ should be choice No. 2, and so on up to No. 5. In particular, if choice No. 5, "All suggested answers are incorrect," is always used for a mislead, it should be the correct answer in ⅕ of the problems.

A method of making sure that the correct answer occurs the proper number of times in each of the five positions, such as 12 times in each position for a 60 question test, is to write the number 1 on 12 pieces of paper, the number 2 on 12 pieces of paper, and so on up to the number 5. Place these 60 pieces of paper in a box, shake the box well, and then draw out the pieces of paper, one at a time. If the first drawing is No. 2, the correct answer for question No. 1 should be placed as the second choice.

Directions and Scoring

After the questions for the examination have been selected, but before the test is printed or mimeographed, an important task remains, that of writing the directions. These should be written as simply as possible, using words with a small number of syllables and employing simple short sentences. At least one and preferably more typical illustrations should be added. Writing directions is an art which some people possess naturally, but much can be learned about good understandable writing from a book by Flesch (2).

Scoring a multiple choice objective test presents another problem. Some authors of tests prefer to count only the correct answers. Others prefer to correct for the element of chance in a five choice test by using the formula, rights minus one quarter of the wrongs. The advantage of a correction for guessing is that it eliminates the personality factor of taking a chance. Under the first system of scoring, a cautious individual who takes no chances is penalized when he is competing with a daring individual who takes a gambler's chance on every question which he does not know.

Revisions of Tests

After a test has once been given to a large enough group of people, at least 100 and preferably many more, it can be refined and revised to make a much better test by examining each question of the test for three items: the usefulness of the misleads, the difficulty of each question, and the index of discrimination of each question.

To find the usefulness of the misleads, a count should be made of the number of times each incorrect answer is used. If a mislead is never chosen or used only a very few times in comparison with the other misleads, it contributes nothing to the examination and should be replaced if possible by a better mislead. When choice No. 5, "All suggested answers are incorrect," is selected by an unusually large number of students, the implication is that the students can think of more wrong answers than their professors and some of the weaker misleads should be improved.

The next item to be investigated is the difficulty of a question which is defined to be the per cent of pupils out of the total number who answered the question correctly. Questions which are answered correctly by a small per cent of students are considered more difficult than those which are answered correctly by a large per cent. If the examination is to be used on the same kind of students, all questions then should be rearranged in order of difficulty, from easy to hard.

In the revised test it should be noted that the difficulty of a question will sometimes change, since the difficulty of a question seems to be partly a function of its position as is shown by Monroe and Englehart (6), page 187.

The question as to which problems should be kept and which should be rejected on the basis of difficulty usually can be solved by retaining those problems which are answered correctly by 30% to 70% of the group as has been shown by Thurstone (7). However, in some cases it is advisable to go beyond these limits. For instance, a good rule to follow is to make at least the first question so easy that everyone can answer it and thus acquire some self-confidence. If the examination is to be a competitive one, enough difficult but fair questions should be inserted to separate the best pupils of the group from each other and

from other members of the competing group.

Discriminatory Value of Problems

Finally, to make the test even better, the discriminatory value of a problem should be computed. Briefly such a value shows how well a particular question separates the persons who were most successful on an examination from those who were least successful. For instance, if as many persons who made scores in the upper quarter of the group answered the question correctly as did those from the lower quarter, the item contributed nothing toward separating those who did best on the examination from those who did poorest, and hence is a useless question. There are many methods of computing this discriminatory ability of a question, some of which are shown in Guilford (3) pages 295–297 and in Monroe and Englehart (6), page 184.

For most purposes, however, these very fine instruments for measuring the discriminatory power of a question are not necessary, particularly since some of them are rather laborious to apply. An easy method which gives roughly the same result is to compute an index of discrimination called D. To compute D, the whole group of examination papers, or a random sample of at least 100 papers, are arranged in descending magnitude on the basis of total scores, from the highest score to the lowest score. From these, the upper quarter and the lowest quarter are selected. Next, for a given question the per cent is computed of those in the upper quarter who answered the question correctly and then the per cent of those in the lower quarter who answered it correctly. If these per cents are U and L, then $D = U\% - L\%$. Thus if 70% of the students in the upper quarter, as measured by the total test, answered a question correctly and 20% in the lower quarter, $D = 70\% - 20\% = 50\%$ or 0.50. The limits of D are from -1 to $+1$. Experience has shown that D should be larger than 25% or 0.25. Problems with D lower than 25% should be rejected, unless there is a special reason for keeping them. Illustrations of the computation of D are shown in Table 1.

TABLE 1

SAMPLE DISCRIMINATORY VALUES

	Problem A	Problem B	Problem C
Upper quarter	80%	40%	10%
Lower quarter	20%	40%	15%
D	60%	0%	−5%

In Table 1, for problem A, 80% in the upper quarter answered the problem correctly, but only 20% in the lower quarter. Since $D = 80\% - 20\% = 60\%$, this is an excellent problem, as far as its ability is concerned to separate the best students from the poorest ones. Problem B is a poor problem because as many persons in the upper quarter answered the question correctly as did those in the lower quarter, and hence the problem fails to discriminate between the best students and the poorest ones. Problem C with a negative value of D also is a poor problem. It is very possible that it is so difficult that it becomes a guessing problem where the weak students, as sometimes happens, are better guessers than the bright ones.

Whenever D becomes very small or negative for a problem which the author thinks should be an acceptable problem, the key to the answers should be examined to be sure the author has not made a mistake. Errors in the key on the part of the author will frequently show up as problems of great difficulty or low discriminatory power.

When a number of examinations have been made so that a fairly large number of problems has been obtained for which the difficulty and the discriminatory values are known, these problems can be filed in a card catalogue with one problem to a card. Thurstone (8) has shown how from this collection of problems,

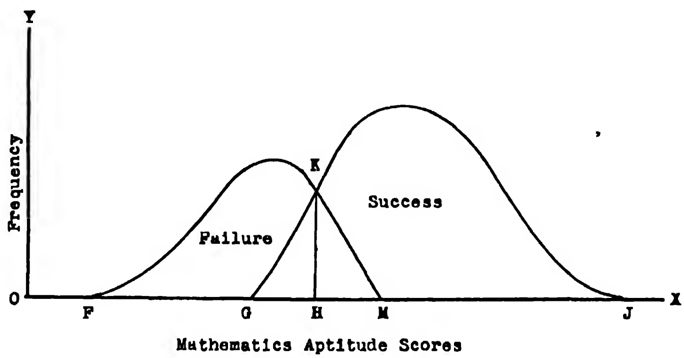
other examinations can be made by selecting problems whose characteristics are fairly well known and how such a collection of problems can be increased, without materially affecting the entire examination, by adding a few new problems each time.

Tests for Predictive Use

Examinations sometimes are used for predictive purposes, such as predicting success in a subject from an aptitude test or predicting success in college from an entrance examination. In such cases, it is necessary to compute what is called a critical or cut off score. In computing such a score, it is necessary to determine in advance what is to be measured and which instrument will best do the measuring. The latter problem usually is solved by finding correlation coefficients between various tests and grades or scores in a subject. When a good predictive test is found, the next problem is that of finding the critical score. A definition for a critical score on a test is a score above which the odds are in favor of a student making a satisfactory performance and below which the odds are against him. An excellent discussion of critical scores is given in Guilford (3), pages 181–187.

To see how such a score is computed, suppose that a certain mathematics aptitude test is a good predictor for success in college algebra. First a trial run is made of students who have taken the mathematics aptitude test and who also have taken a course in college algebra and received a grade in that course. Suppose that the grading system is such that grades A, B, and C are considered satisfactory or passing grades, whereas grades of D and E are considered as unsatisfactory or failing grades.

The critical score is obtained by drawing a graph as in the graph.



Mathematics aptitude scores are plotted on the x-axis, and the number of students making passing grades or failing grades, as the case may be, on college algebra is plotted parallel to the y-axis. The curve GKJ is obtained by plotting the number of students who have passed the course against their mathematics aptitude score. Similarly, the curve FKM is obtained by plotting the number of students who failed the course against their mathematics aptitude score.

If the letters G, H, and M, which stand for points, are also allowed to represent their respective mathematics aptitude scores, then it is obvious that the critical mathematics aptitude score lies somewhere between G and M. The reason for such a statement is that all students who have a mathematics aptitude score greater than M have passed the course, whereas all students who have made a mathematics aptitude score less than G have failed the course.

The critical mathematics aptitude score

in Fig. 1 is defined to be H, which is the abscissa of the point where the curve FKM intersects the curve GKJ, and for this reason, if a score is selected higher than H, it is true that there will be some students who fail the course, as is seen from the curve KM; but it is also true that there will be more students who pass the course for every mathematics aptitude score greater than H, as is seen by the curve KJ. Hence, the odds for a student who makes a mathematics aptitude score greater than H are in favor of his passing the course. On the other hand, if a score is selected lower than H, it is true that some students with this score will pass the course, as is seen by the curve GK; but it is also true that more students will fail the course for every mathematics aptitude score less than H, as is seen by the curve FK. Hence, the odds for a student who makes a mathematics aptitude score less than H are against his passing the course. At H the odds are even as to whether a student will pass or fail the course in college algebra. Hence, H is defined to be the critical score. If the mathematics aptitude test is chosen as one of the tests for an entrance examination and it is desired to select only those students who have the best chance to pass college algebra, then the least injustice will be done to the applicants for admission, if those making a score higher than H are admitted and if those making a score lower than H are rejected.

In an actual situation it never is necessary to plot the curves as is shown in Fig. 1. The critical score can be computed by any engineer, since all engineers know how to interpolate. An illustration is given in Table 2.

In Table 2, the numbers in the fourth column are equal to the number who passed minus the number who failed. The critical score is such a score that the number who passed equals the number who failed. Hence, it is necessary to know what mathematics aptitude score will give a value of zero in the fourth

TABLE 2

COMPUTATION OF A CRITICAL SCORE

Mathematics Aptitude Score	Number Passing	Number Failing	Difference
60	12	4	8
55	9	11	−2

column. This score obviously lies 2/10 of the way from 55 to 60 and, hence, equals 56.

Unfortunately in actual practice the situation sometimes is not as simple as Fig. 1 would seem to indicate. For instance, the success curve may cross the failure curve several times, and occasionally the failure curve may lie entirely within the success curve. Such cases mean either that the test used for predictive purposes is useless or else that the population used to compute the critical score is not large enough to overcome the errors which always are present in any testing process.

The method used in Fig. 1 for determining the critical passing or failing score, H, can also be used to predict from the proper aptitude test, the score above which the odds are in favor of a student receiving a given grade. If it is desired to know the score on the aptitude test which will separate the A students from the B students, all that is necessary to do is to replace the success curve by a curve showing the distribution of students making an A and to replace the failure curve by a curve showing the distribution of students making a B. The abscissa, H of the point K, where the curves cross will give an aptitude score, above which the odds are in favor of a student making an A and below which the odds are in favor of his making a B or a lower grade.

Illustrative Examples

Some illustrations of the kinds of problems to be found in a mathematics achievement test are given in problems A, B, and C.

PROBLEM A

$\frac{1}{4}$ divided by 2 is equal to

(1) $\frac{1}{2}$ (2) 8 (3) $\frac{1}{8}$ (4) 2

(5) All suggested answers are incorrect.

PROBLEM B

$$\frac{3}{p} + \frac{3}{q} =$$

(1) $\frac{3(p+q)}{pq}$ (2) $\frac{6}{p+q}$ (3) $\frac{3}{p+q}$

(4) $\frac{3}{pq}$ (5) All suggested answers are incorrect.

PROBLEM C

$$2^{100} + 2^{100} =$$

(1) 2^{200} (2) 4^{100} (3) 4^{200} (4) 2^{101}

(5) All suggested answers are incorrect.

The numerical characteristics of these problems, when they are analyzed, are given in Table 3.

The first column of Table 3 gives the letter designation of the problem used in the illustration. The number following the letter gives the group which was used in analyzing the problem. Group (1) was composed of engineering freshmen who were admitted during 1942 or earlier without entrance examinations on the basis of a satisfactory high school transcript. Group (2) was composed of engineering freshmen who were admitted in September 1948 and who had to pass an entrance examination in addition to submitting a satisfactory high school transcript. Group (3) was composed of students who entered with satisfactory advanced standing and who had to pass, in addition, an entrance examination. Since most of group (3) students were sophomores, it will be referred to as the sophomore group. Group (4) was composed of part time students who were admitted without high school transcripts or entrance examinations, so long as they were not candidates for a degree. They were given a placement examination to ascertain what course in mathematics they might study with a fair degree of success. Usually they were older men with a great deal of ambition to get more education. Fortunately questions A and B happened to appear both on the freshmen entrance examination and on the placement examination, thus shedding some light on some of the problems of adult education.

The column headed 1 gives the per cent of those who attempted the problem and who selected choice No. 1 for the correct answer. Those who omitted the problem were not counted. A similar interpretation is given for the columns headed 2, 3, 4, and 5. For each problem, A, B, and C, column 5 was the choice, "All suggested answers are incorrect," but for none of these three problems was this answer the correct one.

TABLE 3

ANALYSIS OF PROBLEMS A, B, AND C

Problem	1	2	3	4	5	Difficulty	D
A (1)	7	3	89*	1	0	89%	0.14
A (2)	7	2	91*	0	0	91%	0.15
A (4)	11	4	81*	1	2	81%	0.20
B (1)	42*	43	8	2	5	42%	0.77
B (2)	84*	10	3	1	3	84%	0.49
B (3)	97*	2	0	0	0	97%	0.06
B (4)	49*	36	6	1	8	48%	0.65
C (1)	18	46	14	6*	16	6%	
C (3)	13	34	3	24*	25	24%	0.26

* The correct answer.

The column headed "Difficulty" gives the per cent of the group, including those who omitted it, who answered the problem correctly. High numbers are associated with easy problems, whereas low numbers indicate difficult problems. The column headed "D" gives the discriminatory value, D, of the problem.

Analysis of Results

Problem A (1) turned out to be an easy problem for the freshmen of group

(1), 89% of them having answered it correctly. When given to the more selected freshman group (2), it turned out to be slightly easier, since 91% of those freshmen answered it correctly. At the same time, its discriminatory value remained virtually unchanged. Ordinarily Problem A should be rejected; but it turns out to be an excellent problem with which to begin an examination, since it is not so easy as to appear ridiculous, but easy enough to give about 90% of the examinees a good start.

Problem B (1) turned out to be a problem of moderate difficulty for the freshmen of group (1), since 42% of the group answered it correctly. Its discriminatory value of 0.77 makes it an excellent problem to separate the better students from the weaker ones. Problem B (2) illustrates the effect of an entrance examination in preventing weak students from even entering the Institute. Whereas Problem B acted as a question of moderate difficulty with group (1), the same problem became an easy problem for the more selected group (2). At the same time, it still had a good discriminatory value of 0.49. One mislead, No. 4, should be changed, if possible, to a mislead which is more plausible.

Problem B (3) illustrates both the effect of an entrance examination and the screening effect of at least one year in college. Not only has Problem B for the sophomores become too easy, since 97% of them answered it correctly, but it also has now lost its discriminatory power, since D has been reduced to 0.06. Problem B is useless in an entrance examination for college sophomores.

Problem C (1), with a difficulty of 6%, turned out to be too difficult a problem for an entrance examination for freshmen. Its discriminatory power with group (1) unfortunately is not known but must be very small. It should be rejected on an entrance examination for freshmen, unless it is placed at the end of the test and used to select those students from the less than 1% of the population who have real mathematics ability.

Problem C (3), used with sophomores, still remains a difficult problem with the questionable discriminatory ability of 0.26. If the per cent of those who selected the wrong choices of 1, 2, and 3 for group (3) is compared with the corresponding per cents for group (1), it is seen that all three are less. In other words, the sophomores are much less gullible than the freshmen; they have become educated. However, the per cents of those who selected choice No. 5 also shows that the sophomores can think up more wrong answers than the freshmen.

The data in row A (4) and row B (4) show the troubles that instructors experience when teaching part time students, even if they are ambitious. A simple problem like A turned out to be more difficult for the part time students than for the weakest freshmen class. Problem B was only slightly easier for the part time students as compared to the weakest freshmen class, but the high value of D, 0.65, shows that students in the lowest quarter were very poor.

Value of Problem Analysis

An analysis of problems does for an examination what tests do for instruments used by engineers. No engineer would consider the design of a machine complete until he had tested its reliability. No scientist would use a sextant, a stress analyzer, or a balance unless he either knew its reliability or felt that it was a reliable instrument constructed by a responsible firm. Nevertheless, instructors frequently use examinations and base important decisions on them for their students without knowing the reliability and basic characteristics of the tests which they have used. It is true that situations do exist particularly where judgments are based on other considerations than a single test, where it is not necessary for the test to be a first class instrument. However, any test can be improved by determining objectively if a given problem is adapted to the group for which it has been designed through computing its difficulty and by

determining if it is carrying its load through the computation of its discriminatory value. Furthermore, an analysis of test questions sometimes makes it possible to ascertain how far out of line the teaching of a subject is from what it ought to be.

The methods and illustrations which have been given, show not only the need for problem analysis but also how easy such a task really is, and how easy it is to construct a good examination, if a person goes about it in the right way.

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College Notes

Captain John C. Gebhard (C.E.C.), U.S.N., Retired, who supervised the construction of the U. S. Naval Training Center at Sampson, N. Y., and other important, high-speed building projects for the Navy during World War II, has joined the Civil Engineering faculty of **Cornell University.**

New appointments to the Graduate School of **Stevens Institute of Technology** include Wilhelm Ornstein, associate professor at Newark College of Engineering as visiting professor of mechanical engineering; Hans Arnold Panofsky, associate professor at New York University, as visiting professor of meteorology; Gregory H. Wannier, member of the technical staff of Bell Telephone Laboratories, as adjunct associate professor of mathematics and physical science; Marvin Gimprich, consultant at the Stevens Experimental Towing Tank, as adjunct associate professor of fluid dynamics.

Chester A. Arents has been appointed assistant dean of engineering at **Illinois Institute of Technology,** it was announced by Dr. John T. Rettaliata, dean of engineering. Arents has been associate professor of mechanical engineering. He joined the staff in 1947, after serving a year as associate professor at Montana State College. From 1943 to 1946 he was assistant professor at Oregon State College.

The Ohio State University—Wright-Patterson Graduate Center

By S. M. MARCO

Professor of Mechanical Engineering

and C. J. PEIRCE

Professor of Aeronautical Engineering

Ohio State University

Introduction

In order to encourage graduate study and research in engineering, physics, mathematics, chemistry, physiology, economics and related fields, The Ohio State University, in 1946, instituted a Graduate Center at Wright-Patterson Field, Dayton, Ohio, in cooperation with the Air Materiel Command and the Air Force Institute of Technology. The institution and development of this Graduate Center has been carried out under the terms of a contract between the Air Materiel Command and The Ohio State University. This contract has now been in force for more than three calendar years.

The purpose of this Graduate Center, away from the physical boundaries of the University campus, is to provide on-the-job opportunity for qualified personnel of the Air Materiel Command to pursue graduate research and study under university conditions. In principle the Wright-Patterson Graduate Center is considered as an extension of The Ohio State University Graduate School.

Under the terms of the contract the Air Materiel Command provides the necessary funds for the program. The cost of instruction, administration at the Graduate Center, transportation, etc., are charged against these funds. In addition, the students enrolled in the courses pay the regular University fees assessed against part time students in the Twilight School. These fees cover the cost of administration on the University campus.

The Graduate Center is operated under the same rules which apply to the Graduate School on the campus. It is, therefore, directly responsible to the Dean of the Graduate School in regard to academic procedures. Since the program at the Graduate Center is a part time, in-service program, the business details are administered by the Director of the Twilight School on the campus at Columbus.

A full time administrative staff, responsible jointly to the Dean of the Graduate School and the Director of the Twilight School, is maintained at the Graduate Center. It cooperates with the Dean of the Graduate Division of the Air Force Institute of Technology in unifying and supplementing the administration of the program.

The program of each department offering work at the Graduate Center is under the direction of the department chairman or a member of the staff of the department appointed by the chairman.

The Graduate Center Faculty

All members of the Graduate Center Faculty must meet the requirements and have the approval of the Graduate School. These faculty members may be

classified into three categories. First, there are the members of the faculty on the campus. These men, besides being members of the appropriate departmental and college faculties, are also members of the Graduate School faculty. They are selected by the appropriate department to teach and to act as advisors to students in the programs leading to degrees at the Graduate Center. Since this is in addition to their regular University duties, they receive extra compensation for this work.

A second group of members of the faculty are those who are members of the faculty of some neighboring college or university. They are selected by the appropriate Ohio State University department and must meet all of the requirements which that department has for its regular staff members and in addition they must meet the requirements of the Graduate School. These men are employed on a part time basis.

The third group of faculty members consists of qualified employees of one of the laboratories at Wright-Patterson Field. These men are also selected by the appropriate Ohio State University department and must meet the same requirements that are imposed on the two groups previously described. Proper arrangements for their time and compensation are made with their supervisors at the Field.

The problem of securing adequately trained instructors to carry on the program covering numerous fields of specialization has been a difficult one to handle. The instruction, to a large extent, has been handled by The Ohio State University personnel. However, in some instances, it has been necessary to supplement the instructional staff by the procurement of the services of instructors connected with other universities in the vicinity. The distribution of teaching personnel during the Winter Quarter of 1949 reflects this policy as shown herewith:

University or Organization	Number of Instructors
Ohio State University	20
University of Dayton	2
Antioch College	1
Wright-Patterson Field	4
Kettering Foundation	1
Total	28

The selection of courses by individual students following a degree program is entirely under the direction of a regular member of the department responsible for that program. The teaching of classes may be done by any of the staff members previously mentioned. The supervision of research for thesis purposes and examination of candidates for degrees are under the direction of regular members of the appropriate Ohio State University departments.

Registration of Students

Any civilian or military employee of the Air Materiel Command at Wright-Patterson Field who meets the requirements for admission to the Graduate School at Ohio State University is eligible for admission to the Graduate Center. These men follow the same procedure for admission to the program and registration in its courses as is followed by graduate students on the campus. Upon admission to the Graduate School the student is assigned an advisor who helps him to plan his program. If the student is working for a graduate degree he must meet all the requirements for a degree that are imposed upon regular graduate students for retention in the program.

The mechanics of the registration and the fees paid by Graduate Center students are the same as those which apply to Twilight School students on the campus. The student can complete his registration and pay his fees at the Graduate Center so that it is unnecessary for him to go to Columbus for this purpose.

In addition to regular graduate students, the Graduate Center is open to a few advanced undergraduates who may

be admitted to courses which are open to both graduate and advanced undergraduate students on the same basis that they would be admitted to these courses on the University campus. They may register as special students in the appropriate college in the University. They must have a good record and at least a junior standing from an accredited college from which they transfer. The number of such students who are accepted is limited to the number which can be admitted without overcrowding existing courses.

Methods of Instruction

The classes are all taught in the building at Wright Field which houses the Air Force Institute of Technology. The courses carry the same numbers and are taught on the same basis as the corresponding courses on the University campus. They are courses which have been approved for graduate credit on the campus and usually follow the same outline that is followed there.

Classes are scheduled from 3 to 4:30 and from 4:30 to 6 in the afternoon. They are usually alternated each week so that a student who has a 3 to 4:30 class one week will have a 4:30 to 6 class the following week. In this way the student is in class one-half the time on his own time and the other half on his employer's time. Each student may carry up to a maximum of 6 credit hours each quarter. This means that an individual student carries one or two courses each quarter.

Instruction was started at the Wright-Patterson Graduate Center in the Winter Quarter of 1946.

WINTER QUARTER, 1946

Department	*Title*
Mathematics	Advanced Calculus
Electrical Engineering	Network Analysis and Synthesis
Physics	Advanced Electricity

From this beginning with three courses the program has rapidly developed and an indication of the growth can best be given by listing the work given during the Winter Quarter of 1949.

WINTER QUARTER, 1949

Department	*Title*
Aeronautical Engineering	Aircraft Structural Analysis
Aeronautical Engineering	Modern Aircraft Propulsion
Aeronautical Engineering	Missile Ballistics
Aeronautical Engineering	Rotary Wing Theory
Aeronautical Engineering	Mathematical Aeronautics
Business Organization	Business Law—Negotiable Instruments
Chemical Engineering	Chemical Engineering Thermodynamics
Chemical Engineering	Advanced Chem. Eng. Thermodynamics
Chemical Engineering	Chemical Engineering Kinetics
Chemistry	Organic Micro and Semi-Micro Analysis
Chemistry	Colloid Chemistry
Economics	Labor and Government
Economics	Principles of Social Economy
Electrical Engineering	Analysis of Electrical Engineering Problems
Electrical Engineering	Network Analysis and Synthesis
Industrial Engineering	Engineering Economy
Industrial Engineering	Special Problems
Mathematics	Differential Equations
Mathematics	Advanced Calculus
Physics	Modern Atomic Spectroscopy
Physics	Theory of Vibrating Systems
Psychology	Mental and Educational Tests

In addition to the foregoing courses, research courses can be taken in each of the major fields.

Research and Thesis Work

Those students doing research work have regularly scheduled conferences with their advisors. The research work may be carried on in one of the laboratories at the Field. The research topic must be approved by the student's advisor and also by the supervisor of the laboratory in which the student is employed. These subjects in engineering may be experimental, analytical or both. An attempt is made to select a thesis subject closely connected with the work the student is doing in the laboratory in which he is employed. Non-classified subjects are selected if it is possible. If it is necessary to select classified subjects special arrangements have to be made to satisfy the security requirements. The laboratory facilities for research work are extremely good since the various laboratories at the Field are equipped as well as or, in many instances, better than the regular University laboratories.

Library Facilities

The library facilities at the Graduate Center are moderately good. There is the library of the Air Forces Institute of Technology, located in the same building as the Graduate Center, which is available for the use of the students registered in the Center. In addition to this library, the extensive general Wright Field libraries are, with proper restrictions, available for reference work. Another extremely good source of reference material is the large number of reports of research work carried out by outside contractors for the various laboratories at the Field. These reports are usually available at Wright Field long before they are available for general distribution. The contacts made by the students with outside contractors are another fruitful source of information for research reference which is not so readily available to students on the University campus.

Transportation

The problem of transportation of faculty personnel from The Ohio State University campus to the Graduate Center has been handled in several ways. The private cars of the faculty are used, the University car stationed at Don Scott Airport is also utilized and a Beech C-45 seven passenger airplane on loan from the Air Forces has been of value in this connection. The airplane has operated several quarters, making four round trips per week from Don Scott Field to Wright Field. The use of this airplane has resulted in considerable saving of time on the part of the faculty personnel.

Concluding Remarks

It is the opinion of the writers of this paper that the Graduate Center at Wright-Patterson Field is valuable to the students at the Center, to the Air Materiel Command and to The Ohio State University.

The students at the Center are benefiting because they are able to get in-service university training and thus increase their store of knowledge. Furthermore, in a number of cases, they are able to meet the requirements for the master's degree. Thus, these students are able to increase their own competence and, therefore, their value to the Air Materiel Command.

The Air Materiel Command is benefited by this program because of the increased competence of its present personnel. In addition to this it can use the Graduate Center program as an added inducement for attracting and retaining desirable personnel. Another source of benefit to the Air Materiel Command is the contact between its personnel and The Ohio State University faculty members. These contacts have, on a number of occasions, resulted in consultations, with mutual benefits, on problems of re-

search and development being carried on by the Wright-Patterson Field Laboratories.

The Ohio State University benefits because of the relations which its staff members have with the personnel of the Wright-Patterson Field Laboratories. They are brought into contact with research problems which are of mutual interest, and this sometimes means that information on problems in the frontiers of their special fields is made more easily available to them. Because of the special facilities in some of the laboratories, several of these contacts have resulted in research theses which would have been difficult to carry on with the limited facilities of a university.

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A Neglected Technique in Operational Calculus

By C. R. WYLIE, JR.

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Among the well-known results in Operational Calculus is the following

Theorem: If $f(t)$ is a periodic function with period k, then the LaPlace Transform of $f(t)$ is

$$L(f) = \frac{\int_0^k e^{-st} f(t)dt}{1 - e^{-ks}}.$$

This is a useful and completely straightforward formula for transforming any of the various periodic functions of engineering analysis—rectified sine waves, saw tooth waves, or series of Morse dots, for instance.

On the other hand, the inverse problem of determining the function corresponding to a transform whose denominator contains the factor $(1 - e^{-ks})$, as well as other, purely algebraic factors, seems to be nowhere near as well standardized. McLachlan (1), for instance, solves the problem through the use of the inversion integral and the theory of residues. Gardner and Barnes (2) suggest two methods, one based on the Mittag-Leffler partial fraction theorem, the other on the expansion of the factor $\frac{1}{1 - e^{-ks}}$ in an infinite series of powers of e^{-ks}. Churchill (3) employs the latter process and also an equivalent method based on the convolution integral.

In connection with this expansion procedure (which seems to be the most elementary and natural one) it does not appear to be well known that its results, in all cases of practical interest at least, can be put in a simple, finite form. The purpose of this note is to indicate how this can be done, and to present a short list of such forms in terms of which the inverse of any transform containing $\frac{1}{1 \pm e^{-ks}}$ can be expressed. The manipulations are essentially elementary, and we shall not go into extensive mathematical detail in our exposition. The derivation of one typical formula and the discussion of an example should enable us to say legitimately that the rest "can be left as an exercise for the student."

Suppose, then, that at the penultimate stage in a problem we have the information that the transform of the function we are seeking is

$$F(s) \cdot \frac{1}{1 \pm e^{-ks}},$$

where the denominator of $F(s)$ is assumed to consist solely of real linear and irreducible quadratic factors. If we expand the factor $(1 \pm e^{-ks})^{-1}$ in a series in e^{-ks} we obtain for the transform

$$F(s)(1 \mp e^{-ks} + e^{-2ks} \mp e^{-3ks} + e^{-4ks} \cdots).$$

Now let $g(t)$ be the function of t having $F(s)$ for its LaPlace transform. Under the above assumption regarding $F(s)$ the determination of $g(t)$ presents no problem.

The complete inverse, by the well-known theorem on real translation, can now be written

$$f(t) = \sum_{j=0}^{\infty}(-1)^j g(t - jk)u(t - jk),$$

where $u(t)$ is the familiar unit step function.

For any value of t the above expression for $f(t)$ is clearly a finite sum. Moreover, and this is the neglected technique to which we wish to call attention, this finite series can always be explicitly summed. In fact if the denominator of $F(s)$ contains no repeated factors, $g(t)$ can contain only terms of the form $u(t)$, e^{-at}, $e^{-at}\sin bt$, and $e^{-at}\cos bt$, all of which can be included in the one form e^{-at} if a be permitted to assume complex values. But a series of the form

$$e^{-at} \mp e^{-a(t-k)} + e^{-a(t-2k)} \mp e^{-a(t-3k)} \cdots (\mp 1)^n e^{-a(t-nk)}$$

is just a geometric progression whose sum it is an easy matter to write down and convert to a purely real form.

On the other hand, if the denominator of $F(s)$ contains repeated factors then the typical terms noted above as possibilities can also occur multiplied by powers of t. In this case the general term of the sum which we must consider is of the form $t^c e^{-at}$. Now a series of the form

$$t^c e^{-at} \mp (t - k)^c e^{-a(t-k)} + (t - 2k)^c e^{-a(t-2k)} \cdots (\mp 1)^n (t - nk)^c e^{-a(t-nk)}$$

while clearly not a geometric progression can still be explicitly summed. In fact from the Calculus of Finite Differences, we have the following

Theorem (4): If α be any constant, real or complex, $\phi(j)$ a polynomial of order m, and if $\beta = \dfrac{\alpha}{\alpha - 1}$, then

$$\sum_{j=0}^{n}\alpha^j\phi(j) \equiv \phi(0) + \alpha\phi(1) + \cdots \alpha^n\phi(n)$$

is equal to

$$\alpha^j V(j)\Big]_{j=0}^{j=n+1} = \alpha^{n+1}V(n + 1) - V(0),$$

where

$$V(j) = \frac{1}{\alpha - 1}\{1 - \beta\Delta + \beta^2\Delta^2 \cdots (-1)^m\beta^m\Delta^m\}\phi(j)$$

and Δ is the ordinary difference operator defined by the properties

$$\begin{aligned} \Delta f(j) &= f(j + 1) - f(j) \\ \Delta^2 f(j) &= \Delta f(j + 1) - \Delta f(j) \\ &\cdots\cdots\cdots\cdots \end{aligned}$$

This serves to sum the series, following which it is an easy matter to convert the complex exponentials, if any, into a purely real form.

As a sample derivation, let us find

$$f(t) = L^{-1}\left\{\frac{1}{(s + a)^2(1 + e^{-ks})}\right\}.$$

In this case $F(s)$ is $\dfrac{1}{(s + a)^2}$; hence $g(t) = te^{-at}$. Then fixing our attention on a

general period, say $nk \leqq t \leqq (n+1)k$, we have for $f(t)$ over this interval

$$\sum_{j=0}^{n}(-1)^j(t-jk)e^{-a(t-jk)} \equiv e^{-at}\sum_{j=0}^{n}(t-jk)(-e^{ak})^j.$$

Applying the summation method of the above theorem, we make the following identifications:

$$\alpha = (-e^{ak}), \qquad \beta = \frac{-e^{ak}}{-e^{ak}-1} = \frac{e^{ak}}{e^{ak}+1}, \qquad \phi(j) = (t-jk), \qquad m = 1,$$

$$V(j) = \frac{1}{-e^{ak}-1}\left\{1 - \frac{e^{ak}}{e^{ak}+1}\Delta\right\}(t-jk) = \frac{-1}{e^{ak}+1}\left\{(t-jk) + \frac{ke^{ak}}{e^{ak}+1}\right\}.$$

The required sum is therefore

$$e^{-at}\left[V(j)(-e^{ak})^j\right]_{j=0}^{j=n+1}$$

$$= e^{-at}\left[\frac{-1}{e^{ak}+1}\left\{t - \overline{n+1}k + \frac{ke^{ak}}{e^{ak}+1}\right\}\left\{-e^{ak}\right\}^{n+1}\right] - e^{-at}\left[\frac{-1}{e^{ak}+1}\left\{t + \frac{ke^{ak}}{e^{ak}+1}\right\}\right]$$

$$= (-1)^n e^{-a(t-\overline{n+1}k)}\frac{(t-\overline{n+1}k)(e^{ak}+1)+ke^{ak}}{(e^{ak}+1)^2} + e^{-at}\frac{t(e^{ak}+1)+ke^{ak}}{(e^{ak}+1)^2}$$

TABLE I

DEFINITIONS FOR $nk \leqq x \leqq \overline{n+1}\,k$

1.	ss(x, k) 'staircase function'	$\equiv$	$n+1$
2.	md(x, k) 'Morse dot function'	$\equiv$	$\dfrac{(-1)^n+1}{2}$
3.	rss(x, k)	$\equiv$	$(n+1)x - \dfrac{n(n+1)k}{2}$
4.	rmd(x, k)	$\equiv$	$\dfrac{(-1)^n+1}{2}x + \dfrac{k}{4}\{1-(-1)^n(2n+1)\}$
5.1	epi(x, a, k)	$\equiv$	$\dfrac{e^{-ax}}{e^{ak}-1}$
5.2	epi$_1(x, a, k)$	$\equiv$	$\dfrac{e^{-ax}}{e^{ak}+1}$
6.1	cpi(x, a, b, k)	$\equiv$	$\dfrac{e^{-ax}\cos b(x+k) - e^{-a(x+k)}\cos bx}{2(\cosh ak - \cos bk)}$
6.2	cpi$_1(x, a, b, k)$	$\equiv$	$\dfrac{e^{-ax}\cos b(x+k) + e^{-a(x+k)}\cos bx}{2(\cosh ak + \cos bk)}$
7.1	spi(x, a, b, k)	$\equiv$	$\dfrac{e^{-ax}\sin b(x+k) - e^{-a(x+k)}\sin bx}{2(\cosh ak - \cos bk)}$
7.2	spi$_1(x, a, b, k)$	$\equiv$	$\dfrac{e^{-ax}\sin b(x+k) + e^{-a(x+k)}\sin bx}{2(\cosh ak + \cos bk)}$
8.1	repi(x, a, k)	$\equiv$	$\dfrac{(x+k)e^{-ax} - xe^{-a(x+k)}}{2(\cosh ak - 1)}$
8.2	repi$_1(x, a, k)$	$\equiv$	$\dfrac{(x+k)e^{-ax} + xe^{-a(x+k)}}{2(\cosh ak - 1)}$

TABLE II

	LaPlace transform	Function $(-k \leq \tau \leq 0,\ nk \leq t \leq \overline{n+1}\,k)$
1.	$\dfrac{1}{s(1 - e^{-ks})}$	$\mathrm{ss}(x, k)$
2.	$\dfrac{1}{s(1 + e^{-ks})}$	$\mathrm{md}(x, k)$
3.	$\dfrac{1}{s^2(1 - e^{-ks})}$	$\mathrm{rss}(x, k)$
4.	$\dfrac{1}{s^2(1 + e^{-ks})}$	$\mathrm{rmd}(x, k)$
5.1	$\dfrac{1}{(s + a)(1 - e^{-ks})}$	$\mathrm{epi}(\tau, a, k) - \mathrm{epi}(t, a, k)$
5.2	$\dfrac{1}{(s + a)(1 + e^{-ks})}$	$(-1)^n \mathrm{epi}_1(\tau, a, k) + \mathrm{epi}_1(t, a, k)$
6.1	$\dfrac{s + a}{(s + a^2 + b^2)(1 - e^{-ks})}$	$\mathrm{cpi}(\tau, a, b, k) - \mathrm{cpi}(t, a, b, k)$
6.2	$\dfrac{s + a}{(s + a^2 + b^2)(1 + e^{-ks})}$	$(-1)^n \mathrm{cpi}_1(\tau, a, b, k) + \mathrm{cpi}_1(t, a, b, k)$
7.1	$\dfrac{b}{(s + a^2 + b^2)(1 - e^{-ks})}$	$\mathrm{spi}(\tau, a, b, k) - \mathrm{spi}(t, a, b, k)$
7.2	$\dfrac{b}{(s + a^2 + b^2)(1 + e^{-ks})}$	$(-1)^n \mathrm{spi}_1(\tau, a, b, k) + \mathrm{spi}_1(t, a, b, k)$
8.1	$\dfrac{1}{(s + a)^2(1 - e^{-ks})}$	$\mathrm{repi}(\tau, a, k) - \mathrm{repi}(t, a, k)$
8.2	$\dfrac{1}{(s + a)^2(1 + e^{-ks})}$	$(-1)^n \mathrm{repi}_1(\tau, a, k) + \mathrm{repi}_1(t, a, k)$

or, dividing the top and bottom of each fraction by e^{ak},

$$(-1)^n e^{-a(t-\overline{n+1}k)} \frac{(t - \overline{n + 1}k)(1 + e^{-ak}) + k}{2(\cosh ak + 1)} + e^{-at} \frac{t(1 + e^{-ak}) + k}{2(\cosh ak + 1)}.$$

The second fraction is clearly independent of n, i.e. is of the same structure in all periods. Because of the factor e^{-at} it is of negligible importance after the first few periods.

To achieve a more symmetric form, let us write $\tau = t - \overline{n + 1}k$ in the first fraction. The variable τ thus ranges from $-k$ to 0 as t ranges from nk to $\overline{n + 1}k$ Then the above function becomes

$$(-1)^n e^{-a\tau} \frac{\tau(1 + e^{-ak}) + k}{2(\cosh ak + 1)} + e^{-at} \frac{t(1 + e^{-ak}) + k}{2(\cosh ak + 1)}$$

or, rearranging slightly,

$$(-1)^n \frac{(\tau + k)e^{-a\tau} + \tau e^{-a(\tau+k)}}{2(\cosh ak + 1)} + \frac{(t + k)e^{-at} + te^{-(at+k)}}{2(\cosh ak + 1)}.$$

The first of these fractions yields the same set of values, except for the alternating sign, in all periods. It is therefore the steady-state portion of the inverse.

Without further proof we shall now list additional forms, analogous to the one just derived, in terms of which the inverse of $F(s)\dfrac{1}{1 \pm e^{-ks}}$ (after $F(s)$ has been broken down into partial fractions) can be expressed. To do this conveniently we shall coin a number of functional symbols to describe compactly the combinations of elementary functions to which we shall refer. In each case the notation is at least mildly suggestive. Thus the letters *pi* suggest 'periodic inverse.' The letters *e, c, s* suggest respectively 'exponential,' 'cosine,' and 'sine.' The letter *r* suggests the adjective 'repeated.' Functional titles without subscripts identify functions associated with LaPlace transforms containing the customary factor $\dfrac{1}{1 - e^{-ks}}$. The subscript 1 identifies a function associated with an L-transform containing $\dfrac{1}{1 + e^{-ks}}$.

The transient components (t-evaluated components) of all inverses are continuous for all $t > 0$. This is true of the steady state terms (τ-evaluated components) of the inverses only if the order of the denominator of $F(s)$ exceeds by more than one the order of the numerator. When the order of the denominator of $F(s)$ is exactly one more than the order of the numerator there is a 'jump' of $+1$ in the steady state term in crossing each of the period boundaries, $t = nk$, if the associated transform contains $\dfrac{1}{1 - e^{-ks}}$; and a 'jump' of $(-1)^n$ in crossing each period boundary if the associated transform contains $\dfrac{1}{1 + e^{-ks}}$.

Example

A simple series circuit contains the parameters $R = 400$, $L = .2$, $C = 10^{-6}$. At $t = 0$, while the circuit is completely passive, an exponential sawtooth e.m.f. equal to $E_0 e^{-5000t}$ throughout one period, and repeating itself every .002 seconds, is switched into the circuit. Find the total response of the circuit and also the steady state behavior.

The differential equation to be solved is

$$.2\frac{di}{dt} + 400i + 10^6\int_0^t i\,dt = E(t).$$

Taking the L-transform of this equation we have

$$L(i)\left(.2s + 400 + \frac{10^6}{s}\right) = \frac{E_0\displaystyle\int_0^{\frac{1}{500}} e^{-st}e^{-5000t}dt}{1 - e^{-s/500}} = E_0\frac{1 - e^{-5000+s/500}}{(1 - e^{-s/500})(s + 5000)}$$

$$= \frac{E_0 e^{-10}}{s + 5000} + \frac{E_0(1 - e^{-10})}{(s + 5000)(1 - e^{-s/500})};$$

$$\therefore\quad L(i) = \frac{5E_0(1 - e^{-10})s}{(s + 5000)(\overline{s + 1000}^2 + \overline{2000}^2)(1 - e^{-s/500})} + \frac{5e^{-10}E_0 s}{(s + 5000)(\overline{s + 1000}^2 + \overline{2000}^2)}.$$

Now by familiar partial fraction manipulations we have

$$\frac{s}{(s+5000)(\overline{s+1000}^2+2000^2)} = \frac{1}{4000}\left\{\frac{-1}{s+5000}+\frac{s+1000}{\overline{s+1000}^2+2000^2}\right\}.$$

From this point the entire solution can be written down at once:

$$i = \frac{5E_0e^{-10}}{4000}\{-e^{-5000t}+e^{-1000t}\cos 2000t\}$$
$$+\frac{5E_0(1-e^{-10})}{4000}\left\{\operatorname{epi}\left(\tau, 1000, 2000, \frac{1}{500}\right)-\operatorname{epi}\left(t, 1000, 2000, \frac{1}{500}\right)\right\}$$
$$-\frac{5E_0(1-e^{-10})}{4000}\left\{\operatorname{epi}\left(\tau, 5000, \frac{1}{500}\right)-\operatorname{epi}\left(t, 5000, \frac{1}{500}\right)\right\}.$$

The steady state is described by the terms in τ:

$$i_{ss} = \frac{5E_0(1-e^{-10})}{4000}\left\{\operatorname{epi}\left(\tau, 1000, 2000, \frac{1}{500}\right)-\operatorname{epi}\left(\tau, 5000, \frac{1}{500}\right)\right\}$$

or, written out at length,

$$i_{ss} = \frac{5E_0(1-e^{-10})}{4000}\left\{\frac{e^{-1000\tau}\cos 2000\left(\tau+\frac{1}{500}\right)-e^{-1000(\tau+1/500)}\cos 2000\tau}{2(\cosh 2-\cos 4)}-\frac{e^{-5000\tau}}{e^{10}-1}\right\}.$$

This function, plotted for $\frac{-1}{500} \le \tau \le 0$, defines one complete cycle of the steady state behavior. Of course the unit 'jumps' in $\operatorname{epi}(\tau)$ and $-\operatorname{epi}(\tau)$ at the ends of each period just cancel, leaving the steady state function continuous, as of course it must be.

References

1. McLachlan, N. W.: "Modern Operational Calculus," p. 136.
2. Gardner, S. M., and Barnes, J. L.: Transients in Linear Circuits," p. 240.
3. Churchill, R. V.: "Modern Operational Mathematics in Engineering," p. 93.
4. Milne-Thompson, L. M.: "The Calculus of Finite Differences," p. 46.

Teaching Elementary Column Theory

By PHILIP K. ROOS

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The derivation of the Euler equation is often a first step in the teaching of columns. This basic form can be derived by the same moment-area method which proves such a useful tool in the calculation of deflections in flexural members. Its application to columns has been noted by Professor Van Den Broek in his book on limit design and Professors Sutherland and Bowman in their text on structural design. This use is based on the assumption that the deflection curve and the moment diagram for the column, as the axial load approaches a critical value, are both sine curves.

The first step in the use of this method is to point out to the student, with illustrations, that he knows the areas and centroids of many geometric figures in terms of certain constants and the intercepts the figures make with the coordinate axes. Then set him the problem of finding the constants that will give him the area and centroid of the sine curve between 0° and 90° when the intercepts on the x and y axes are in the general terms b and a instead of the specific $\pi/2$ and 1. The expression for area will turn out to be $A = \frac{2}{\pi}ab$, and for centroidal distance along the x axes measured from 0°, $\bar{x} = \frac{2}{\pi}b$.

When this is done, the deflected shape of a pinned-end, axially loaded column of length L and load P can be studied to see how Theorem II of the moment-area principles can be applied to find the maximum deflection Δ of the column. Then the moment diagram, which is a sine curve with a length L and a maximum ordinate or moment of $P\Delta$, should be drawn. In the general expression for the maximum deflection $EI\Delta = A\bar{x}$, A will be equal to $\frac{P\Delta L}{\pi}$. and $\bar{x}$ will be equal to $\frac{L}{\pi}$. The general expression then reduces to the Euler expression for the critical buckling load $P = \frac{\pi^2 EI}{L^2}$.

In some texts the general case considered is the column fixed at one end and free at the other end with a length L and a load P at the free end. In this case, $\bar{x} = \frac{2L}{\pi}$, $A = \frac{2P\Delta L}{\pi}$ and the expression for the critical load becomes $P = \frac{\pi^2 EI}{4L^2}$. Other conditions of fixed and pinned-end columns are then considered as being made up of some multiple of this general case. These cases are well known and they are recalled here only to indicate the variety of ways this problem can be treated by the moment-area method.

From the viewpoint of engineering education in general, it is important that the students be disabused of any ideas that this is a means of circumventing a mathematical analysis. The form of the differential equation involved can be used to show the student the reason for the basic assumptions. It can thus be shown that a sound basic understanding of mathematics is needed to appreciate when and how a graphical method may be applied.

Co-operative Standards and Criteria*

By JOHN M. HOUCHENS

Associate Professor of Co-ordination, University of Louisville

Because of the shifting emphasis on the relative importance of professional, social, and economic factors, it has become imperative that we re-study the objectives and standards for our various co-operative plans. If we are to do a good job in the co-operative schools in training our students to render effective and efficient service in the engineering profession, the criteria by which we measure the organization and operation of our programs must be sound and adequate.

Dean Freund and his committee on Aims and Ideals of Co-operative Engineering Education did an excellent job in organizing the collective thinking on these matters into the[1] report presented to this society two years ago. It has served as a good basis and an inspiring stimulus for each of us in studying our respective programs.

The writer is presenting some of his observations and thoughts on the matter of standards and criteria as derived from his experiences with the program at the University of Louisville.

It has been an inspiration to note during the post-war re-organization period the soundness of the basic principle of the co-operative system for training young men for their most effective performance in the engineering profession. It is strongly indicated that the co-operative method has an expanded and enhanced significance in this period when the world is so keenly aware of the sociological and economic import of the engineer and his work. Since the achievements of engineers so vitally affect every phase of human existence and activity, it is imperative that they not only have some concept of all the other factors of civilization but also that they learn to organize and apply their knowledge and skill so as to contribute most to the welfare of humanity. Engineers must become more and more a part of the world they so profoundly shape. Engineers can be isolationists no longer without contributing to the detriment and decline of civilization. The co-operative system offers unusual opportunity to introduce this viewpoint to students.

Objectives of Co-operative System

The writer has formulated the following summary of objectives of the co-operative system as a basis for our study and discussion:

1. To provide an opportunity for the student to obtain a clear concept of engineering and to determine whether he is adapted to the profession and to the branch he has chosen.

2. To give the student a background of practical experience under actual industrial conditions: first, in order to help him comprehend more readily the basic principles taught in the various courses and to cause him to appreciate more fully their applications to useful processes and real problems. The second phase of this objective of practical experience is to introduce the student to the methods and techniques of the appli-

* Presented at the Co-operative Engineering Education Division at the Annual Meeting, Austin, Texas, June 14, 1948.

[1] *Proceedings* of the American Society for Engineering Education, vol. liv, p. 117.

cation of engineering principles, *i.e.*, "the engineering know how."

3. To give the student an understanding of the human factors in the industrial and professional world; and to help him develop his personality and tact so that he can deal successfully with the various types of people he must associate and work with in his professional career.

4. To acquaint the student with the economic factors of engineering and industry, particularly the relative value of time, money, and materials.

5. To train the student to meet industrial and professional discipline and demands.

6. To give the student a comprehension of human values and relationships; and to create in him a consciousness and a perspective of his responsibilities to society as a citizen and as an engineer.

It should be borne in mind and constantly emphasized to all concerned—faculty, employers, and students—that the co-operative system is first and foremost an educational program closely integrated with the course work at school and designed to train the student in all the factors involved in the profession.

It is easy and tempting, especially for students, to emphasize some of the incidental values of the co-operative system rather than the main objectives. Especially is this true with respect to the values of making money and the establishing of connections which will be useful in securing employment after graduation. All of us recognize the worth of these and the other incidental values of the co-operative system in their proper relationship and perspective to the ultimate objectives of the program.

Analysis of Objectives

Let us now examine the six principal objectives outlined above.

In accord with item one, the co-operative system introduces the realities of applied engineering and its demands clearly and forcefully to the students early in their careers. It emphasizes to each one all factors, in addition to technical knowledge which are necessary for success in the profession—personality, industry, leadership, initiative, and many others.

We are recognizing more and more that the ability to pursue successfully the academic curricula of an engineering course does not necessarily indicate that a student has all the qualities prerequisite for success in the profession. The co-operative system helps the students themselves, with counsel of the faculty and the employers, to discover their strengths and their weaknesses. With the clearer concepts gained on co-operative work the students should proceed in their courses with more confidence and effectiveness.

As indicated in item two the practical experience of working with and observing the application of scientific principles does much to help students understand the principles already studied in the courses as well as those studied after the experience.

Somewhere in his career the successful engineer must become familiar with the methods and techniques—"the know how"—of the profession. He must learn how to apply the knowledge and principles effectively and efficiently. He cannot learn very much in a short co-operative work period. However, the practical experience of co-operative employment offers him an opportunity to acquire some of the rudiments and concepts of this all important phase of his chosen field.

The objective of having the co-operative student learn the factors and principles involved in getting along with people and in supervising them, as stated in item three, is particularly important because most engineering graduates eventually become administrators and executives. Of course, the co-operative system cannot infuse the innate qualities of leadership. It can, however, help students discover the demands in this field and inspire them to develop their own personalities, attitudes, and techniques accordingly.

To the engineer, the matter of controlling costs in order to make his achieve-

ments practicable and to meet competition successfully has long been a vital factor. Hence item four. Properly planned co-operative programs should emphasize to the students the opportunity to observe the basic principles of cost control as established and practiced by successful industrial and engineering organizations.

Item five recognizes the necessity for self discipline in any vocation. Regardless of his other qualities, an engineer's general attitude, his personal habits, his initiative, his industry, his method of thinking, his thoroughness, his accuracy, and many other such characteristics will play a large role in his success or failure.

With respect to item six, the significance of engineering achievements to the economic, political, and sociological phases of our civilization has already been indicated and stressed in this paper. Likewise the resulting importance that engineers consider these factors in their work and also, participate more actively as citizens in working out the problems has been emphasized. The writer believes that the co-operative system offers a splendid opportunity for the student to recognize the importance of this viewpoint and to develop his thinking along these lines.

Criteria For Success of Co-operative Program

In order for any co-operative plan to be successful in achieving its objectives, it must have certain well defined criteria by which to measure its organization and operation. The following items are presented without much elaboration for our consideration:

1. The basic principles of the co-operative system should be heartily endorsed and actively supported by the administration and faculty of the school.

2. The co-operative plan should be integrated closely with the basic curricula and program of the school in order that all phases of a student's training shall contribute to the ultimate objectives of the course as a whole. In no case should the co-operative work be considered as a separate part of the school's program.

One of the best ways of achieving this co-ordination is through a co-operative work committee consisting of representatives of the administration, the degree granting departments, and the co-ordination department. Such a committee serves in an advisory capacity to the co-ordinators in establishing policies, in evaluating co-operative jobs for their educational value, in selecting students for the respective jobs, and in evaluating the students' experiences.

3. It is particularly important that the executives and the supervisory personnel of co-operating firms understand and endorse the basic objectives of the co-operative system as an educational program. A school must of necessity depend largely on the employer to contribute to the achievement of the objectives.

4. With the co-operation of the employer and the counsel of the co-operative committee, employment programs should be arranged so that each student will obtain the maximum benefit possible with respect to the objectives.

5. It is necessary that the students be made familiar with the concepts and objectives of the co-operative system. Also, they must be effectively inspired to make the most of their experiences and opportunities with respect to the main objectives as well as to the incidental advantages of the system. Hence, the co-ordinators must be on the job continuously.

6. As in plans and programs of all sorts the success of the co-operative system is largely dependent upon those who administer it. The intelligence, general attitude, initiative, and industry of the co-ordinators and their ability to inspire students will determine mostly the effectiveness of any co-operative plan. The work is arduous and requires constant alertness. Problems constantly arise which continually call for ingenuity, diplomacy, and patience. It is easy to see that co-ordinators must be selected with much care.

The co-operative system is designed pri-

marily for the benefit of the students. However, it is not magical; it does not deliver benefits automatically. The system, when properly organized and administered, merely offers an opportunity for development. As in all educational programs the values derived depend mostly upon the student's attitude and industry. If he profits by his co-operative experience, he must work hard; observe things, conditions, and people closely; interpret observations and experiences wisely; formulate sound philosophies; and make people like him. The responsibility and the challenge to every co-operative school is to so organize and administer its plan as to lead and inspire its students to do these things.

Conference on Administration of Research

The Third Annual Conference on the Administration of Research was held at The Pennsylvania State College September 12, 13 and 14, with the following papers being presented:

"University Research and What to Do About It," S. Tour;

"Advancement of Basic Knowledge," F. C. Lindvall;

"Functions of University Research from the Viewpoint of Government," H. L. Dryden;

"Functions of Sponsored University Research," L. A. Hyland;

"Dissemination of Results of University Research," C. G. King;

"Patent Policies," A. M. Palmer;

"Methods for Evaluation of Research," F. Olsen;

"Summary," E. A. Walker.

The "Proceedings" of the Conference will be available approximately February 1, 1950, at a cost of $3.00 per copy. Copies may be obtained by addressing Professor K. L. Holderman at Engineering Extension, Pennsylvania State College, State College, Pennsylvania. Although "Proceedings" of the First Conference are now out of print, there are available a few copies of the Second Conference "Proceedings" at this price.

The Place of the Technical Institute School Graduate in Industry*

By JOHN A. LUNN

Vice President, Dewey and Almy Chemical Co.

This subject is of particular interest and significance to me, first, because of my association a number of years ago in a teaching capacity with a technical institute, and secondly, because of my opportunity to observe the work and accomplishments of many graduates of these institutes in manufacturing establishments and other business institutions. In order to appraise and measure our subject properly, it seems important to me to develop some observations concerning the evolution of our industrial pattern, the changes in our technical education and their respective impacts upon each other.

We need only to go back to the turn of the century to visualize the tremendous industrial changes which have taken place. We have heard references in the public and technical press to the "Mechanical Age"; to "Electricity, The Public Servant"; to "Better Things for Better Living through Chemistry." For the purposes of my discussion, I should like to divide this period into three phases or cycles. Time permits only a very brief comment on these phases.

I. *Mechanization and Tooling Up*

The development of the Automotive Industry is one of the best examples of this period. The impacts of this development were far reaching—foundry practice, sheet steel production, electrical equipment, machine tool development, steel drawing and fabrication, rubber production and manufacture, petroleum refining, and many other large industries were affected by this gigantic development.

II. *Development and Utilization of Efficiency Systems*

Here we can include Taylor and Bedeaux and literally thousands of others. They all served the useful purpose of making industry more conscious of personal productivity. Hundreds of incentive and bonus plans resulted from these systems.

III. *Organized Industrial Research*

Industrial research is here to stay. Industry relies on research to develop new processes and products, to eliminate waste, to develop useful by-products, to produce higher yields and to obtain lower costs.

In addition to these more or less normal developments in the industrial cycle, we have had the violent impact of two World Wars during this period, which had a result much farther reaching than the actual duration of hostilities.

Each of the above factors has had its definite effect on industry's requirements for technically trained men. It is not surprising that American Industry, in practically all of its branches, finds itself understaffed with technical men. Consequently every foreman, supervisor, superintendent, draftsman, designer, and engineer has more rigorous demands upon his judgment, his ability to carry responsibility, to make decisions, to teach and train others, to think and work under pressure.

* Presented before the Technical Institute Division of the New England Section, ASEE, Boston, Mass., October 16, 1948.

Educational Changes

Now let us consider briefly some of the educational changes which have taken place during these periods. The increase in the number of our high school graduates during the last 25 years has been at a rate which is 13 times as great as our increase in population. Consequently, we find today that almost every position involving any responsibility is filled by those having at *least* a high school education. We also find a large proportion of hourly rated jobs filled by high school graduates.

Almost every first rate high school has a Department of Vocational Education, or at least a Counsel for Vocational Guidance. Many *Technical* High Schools give courses in elementary Applied Mechanics, Chemistry, Physics, Electricity, Radio, and Machine Tool Work.

Then we have the trade schools which in general contribute more to the man at the bench and to craftsmen than to those training for supervisory capacities. These opportunity schools augment the training of many who may not have had a high school education. In most of these schools the teaching is of an entirely practical nature for a specific job. Trade schools covering substantialy similar ground are to be found in Great Britain and Germany.

Place of the Technical Institute

The technical institute as we know it in the United States has for its purpose the training of people for positions which occupy an area between the skilled crafts and the highly scientific professions. In Europe we find a number of institutions with kindred objectives: The National Schools of Industrial Arts in France, the higher industrial schools in Germany, The Technical Gymnasia in Sweden, The Technicums in Switzerland, and the so-called local technical institutions in Great Britain.

It is the method of operation of the technical institute in our country and its freedom from narrow regimentation which have made it a significant and vital factor in our educational pattern. It has put technical education within the reach of almost everyone who is willing to work for it. It has helped to make education in the United States a truly democratic force. It has met the challenge of two wars within a single generation and has carried its share of the burden of technical training both during and after these emergencies. Its physical equipment has steadily improved and its educational standards have grown constantly stronger during this period of industrial development.

The primary goal of the technical institute is to serve industries by giving them trained men who can accept and carry the responsibility connected with industrial development. In this connection, I was very much impressed with a chart which has just been prepared and shows graphically the semester hours by subjects which are required for a chemistry major by a technical institute and 5 colleges and engineering degree schools in this area. The requirements of the technical institute compared very favorably with those of the degree institutions. Thus the technical school graduate has been given many new and important tools with which to accomplish the above objective. While the lack of a degree presents a theoretical handicap for some industrial positions, the openings which are waiting for the technical school graduate are literally legion.

Let us enumerate some of them:

Production

Foremen
Supervisors
Superintendents
Production Engineers
Production Planning
Time Study Men
Job Analysis
Inspectors
Quality Control
Laboratory Control
Analytical Laboratory Work
Physical Testing
Inventory Control
Receiving and Shipping

Engineering

Draftsmen
Machine Designers
Equipment Layout
Construction
Power Plant
Maintenance
Efficiency Engineering
Safety Engineers
Master Mechanics
Sales and Service Engineers

In addition, there are many opportunities in other branches of business for the technical school graduate, in purchasing, in industrial relations, in expediting, in traffic management, in sales of technical products, and in a host of other departments.

On the other hand, there are some industrial positions which generally are not open to graduates of the technical school because of very specialized requirements. Here we might include Chemical and Physical Research, Accounting, Tax Work, Legal, Budgeting, Financial, Advertising, Sales Promotion, and the like.

Now let us try to measure the extent to which the technical school graduate is filling this potential. A survey of the positions held by the 1948 graduating class of 305 from a leading technical institute in this area showed the following distribution of its graduates:

20%—In positions allied to their specific training
16%—Drafting, Layout and Design (Mechanical and Architectural)
13%—Miscellaneous
12%—Engineering and Laboratory Assistants
10%—In business for self or with father
8%—Machinists (some doing experimental work)
5%—Pattern-makers and Assistants
4%—Aircraft Mechanics
3%—Carpenters
2%—Teaching
2%—Plant Engineers Assistants
2%—Sales work
2%—In training for Industrial Plant Managers
1%—Obtaining Higher Education

Among graduates of technical institutes may be found Draftsmen, Machine Designers, Machinists, Tool and Die Makers, Engineers, Plant Engineers, Teachers, Superintendents, Salesmen, Insurance and Building Inspectors, Foremen, Sales Managers, Electricians, Production Managers, Contractors, Builders, Architects, Carpenters, Pattern-makers, Manufacturers and many others too extensive to mention.

I think we can conclude that the technical institutes are measuring up to their opportunity in placing their graduates in important and diverse industrial jobs.

Unfortunately time does not permit us to discuss the training offered by the engineering colleges, universities and technical institutions which confer degrees and the extent to which their graduates may be in competition with the technical school graduate. I am reminded of a remark made by a Professor of English in his opening lecture to freshmen in a leading technical institution, which confers both Bachlors and Advanced Degrees—"Gentlemen, this institution has ruined a lot of fine plumbers." If this observation is true, some of this competition may not be of the highest order.

The President's Commission on higher education has reported that the quantitative demand for technical institute graduates is more than 5 times the need for graduates of four-year engineering schools. This is a very significant finding and should prove to be an effective catalyst to the technical institute and its graduate.

An excellent job has been done also by those institutions offering courses which cooperate with industry. This type of basic training has brought industry and education much closer together and has given each a more tolerant appreciation of the other's problems.

In closing, let me state that the technical institute school is carrying its full share of the educational load. Because of the breadth of its base in recruiting students, it is inevitable that some will fall by the wayside, both during their edu-

cational period and when they meet the rigorous requirements of industry. Some will not get immediate recognition but will have to prove themselves on the job. Those who ultimately succeed, however, are hard to dislodge because they are in dead earnest, because they have had sound, basic, practical training and have worked for it every step of the way. Industry relies heavily on such men for a large and important segment of its technical and supervisory organization.

To those of you who have the guidance and teaching of these men, we can only say—continue that objective training program. Train them to be doers. Give them an even greater appreciation of human values and human relations. Teach them *how* to teach others; in a word, *keep up* the good work.

Teacher Qualifications in Relation to Education Outside the Classroom*

By WILLIAM E. RANZ

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In technical education a major controversy of the young student with his training is a spiritual one; and because such an aspect of human behavior seems illusive to technical people, it has not received much attention from modern educators. Consequently, if you seek the student's ideas about his teachers, you will not obtain a lucid, clear-cut answer. His feelings toward his education are more instinct than thought and more heart than mind.

For example, consider a case history.

This man is a mass-produced graduate of a large university. He is a successful young engineer, but he remembers his undergraduate preparation with some bitterness. His grounding in class-room logic, in facts and figures, in forthright scientific and industrial knowledge was in the main a superb foundation upon which to build his later economic success, but he found the process deadly dull and dry as powder. He does not know why the notices of class reunions go into the waste basket with hardly a glance and absolutely no nostalgic twinge of memory, but he is suspicious of the overall merit of his education and has decreed that his son will go to a small school and will not study engineering.

This man was attracted to an engineering education for several reasons. He possessed unusual talents in mathematics and science. He approved of the skeptical, take-nothing-for-granted attitude of the profession. He came from a middle class family and recognized in this occupation a way of economic advancement in a job he enjoyed. Why then does he bear a grudge against his college training?

This student objects to the coldness of his education, to the completely impersonal way technical knowledge was shoved down his throat, to the fact that his formal training for living consisted of classroom facts and figures, and nothing more. In this day of specialization the responsibility for his mental and social development has been delegated haphazardly to his rooming house, the corner drug store, the local bar and night club, his family 500 miles away, his church, his fraternity, his club, and the dean of men who instead of worrying about fifty men worries about five hundred. His education has been entrusted in a host of people each of whom says his job is to deal with just one aspect of the student's total training, and this one aspect alone, disclaiming responsibility for all others. Is it wrong, then, to question the wisdom of over-specialization in education as opposed to a more personalized mentor-system; and to speak of teacher responsibility and influence outside the classroom?

Impenetrable Gulf Between Teacher and Student

Under the system presently developed the student in his Freshman and Sopho-

* Presented at the Chemical Engineering Summer School, sponsored by the Chemical Engineering Division, A.S.E.E., University of Wisconsin, August, 1948.

more years is lucky if he gets within twenty rows of the man with the chalk, who rightly or wrongly is a sort of hero to him. In the last years he becomes well enough known to have a general label of good, bad, or indifferent and a full name to the man who is putting the ideas across the desk; but the teacher-pupil relationship effectively goes no further than a first introduction at a formal party. At no point in his college life has the student met what he instinctively felt was true educational inspiration from a great teacher, all of whom seem to be hidden away somewhere for graduate students and special occasions, or who are so remote that it would have been better to pore over the impersonal text books of the great man and have never entered the campus gate.

If the student has an adviser, he may see him individually, and perhaps alone man to man, fifteen minutes each semester. If he ever had the honor of personally meeting the dean of his college or the president of the university, his crime must have been particularly heinous, and his remaining student days less than none at all.

When the student steps out of the classroom, that moment is the last he will see his professor until the class meets again. If he joins a professional group, he does not find him at the regular meetings. He does find someone else who is low in seniority and is there not because he wants to be there and enjoys directing student activities but because he is required to be there as part of his job. Rarely in his extracurricular activities does the student find the guiding presence of his classroom teachers whose avowed purpose is to prepare him for professional life and who could represent some sort of unifying factor in his education. His idea on how much time his teacher should spend on his training is unfair and unrealistic, but the student unconsciously wants something more from education than the mental tools to attack physical problems.

Instilling Professional Attitudes

Technical training has created groups of professional people who are scurrying around changing our everyday world. Engineering attracts the best talents of the best people because its purpose is well defined, and it moves with certainty obtaining indisputable results. In this profession there is no necessity for lapsing into platitudes on known subjects, and it is dangerous to cover one's tracks with involved verbiage and vague guesses on unknown subjects. But, in an attempt to be completely objective and professional, the engineer, as well as the scientist, has been unaware of the consequence of his achievements, and now awakes to the realization that his work is being misused, that technology is a social and political force and should be treated as such a force. Knowledge in itself is not enough. And by analogy classroom education is not enough.

Recently every engineering curriculum has been altered to include more of the so-called "humanities," but is this the sufficient answer to a need for something more than professional knowledge? Perhaps some extracurricular education by engineering teachers could contribute to a solution, and inject true purpose into the lives of students.

If you are a teacher, what can you say to these questions about each of your many pupils?

What is his background?

Where does he live and what sort of a life does he lead outside the classroom?

Is his social and economic level being improved?

What latent talents worth developing does he possess?

What shortcomings, susceptible to correction, hamper him?

What sort of person is he?

Is he developing into a better man?

Is he being educated with something besides technical knowledge?

The student recognizes a good teacher with unfailing instinct. He is not nec-

essarily the oldest member of the faculty, nor the most brilliant, nor the one with the largest number of scientific papers to his credit, nor the one who gives the best marks, nor the best business administrator, nor the best politician. He is the good classroom lecturer; he takes his work seriously and puts much time in on it; he inspires his pupils with a desire to learn; he is not a cruel taskmaster but demands and gets the very best efforts of his students; he is completely interested in the education of each individual and in his mental and social development; his friendship is respected; his advice and counsel is accurate and effective; he does not pretend but is accepted for what he knows and what he is.

A pupil wants his teacher to be "human," but present practice conspires to make college professors as inhuman and impersonal as possible, little better than the lifeless pages of a textbook. College students cannot expect the exclusive attention of a tutor, but they should be able to hope for some of the personal and human inspiration that a closer teacher-pupil relationship can provide.

When the student walks away from the classroom at the end of a lecture hour or laboratory period, he does not walk away from the process of education. If he is a youth of any talent or any depth he keeps on absorbing experience and knowledge like a sponge. The average university lists for the student 25 hours per week of direct supervision by teachers who are charged with his training. These 25 hours represent only 15 per cent of his student life and, we dare say, about the same percentage of his education for leading a worth-while and useful existence.

Whether or not the teacher should feel responsibility for the education of students outside the classroom is not for us to ask; but we can wonder whether or not the teacher's interest in, and influence on, all phases of the students' education outside, as well as inside, the classroom is not directly propertional to his qualifications and success as a teacher.

ECPD Annual Meeting

The following is a summary of the reports presented by the various committees of the ECPD at its annual meeting, held at the Edgewater Beach Hotel in Chicago, October 28–29, 1949.

Accreditation of Engineering Colleges

A vigorous program of reaccreditation of engineering curricula in engineering colleges has been undertaken by the Engineers' Council for Professional Development, an organization representing the major engineering societies of the country. The first program of accreditation was completed in 1943. Because of wartime restrictions, accreditation was discontinued until 1947. The Committee on Engineering Schools of the ECPD, under the Chairmanship of H. T. Heald, President of the Illinois Institute of Technology, has completed inspection of 114 colleges. Only 39 schools remain to be inspected in the immediate postwar program, and it is anticipated that these inspections will be completed during the coming year. Approximately 74% of all the engineering curricula inspected have been fully accredited; 14% have been provisionally accredited; and 11% have not been accredited.

The Committee on Engineering Schools is also studying the problem of the accreditation of graduate curricula in engineering colleges. This is a difficult problem since there is a widespread diversity in beliefs among educators as to what constitutes the objectives of graduate study. One of the principal undertakings of the Committee on Engineering Schools has been the preparation of a definitive statement as to the characteristics of a good engineering curricula. This will be useful as a guide to administrators of engineering colleges as well as in the work of the accrediting committees. The Committee on Engineering Schools has carefully refrained from specifying course content in engineering curricula, since it believes that engineering colleges should have full freedom in method, procedures, and extent of training. However, the Committee feels that there are certain minimum requirements which an engineering curriculum should satisfy.

The Committee on Engineering Schools has also accredited curricula in thirteen technical institutes.

Professional Training

The Committee on Professional Training of the Engineers' Council for Professional Development, under the Chairmanship of A. C. Monteith, Vice President of Westinghouse Electric Corporation, is making a survey of industrial training programs and educational courses available to the practicing engineer in industry. There is an ever increasing need for continued professional education after the engineer embarks upon his career, and the Committee on Professional Training is endeavoring to encourage such educational programs in order to provide a greater depth and breadth of education for engineers.

The Committee on Professional Training is also preparing material on: (1) professional registration of the young engineer, (2) the engineer's place in the community, and (3) a personal appraisal for engineers.

Student Selection and Guidance

A Committee on Student Selection and Guidance of the Engineers' Council for Professional Development, under the Chairmanship of Z. G. Deutsch, consulting engineer, New York City, is studying the problem of improving the vocational guidance of high school upper classmen. A survey has been conducted which shows that very little effort has been made by professional organizations to assist the high schools in this very important human problem. Plans are being formulated to stimulate a more widespread type of guidance work which would be carried on by public-spirited professional engineers throughout the United States. This Committee is also preparing a new pamphlet which will provide an insight into the profession of engineering and will serve to supply vocational guidance information. The pamphlet will be available to principals, librarians, guidance counselors, and students in high schools and colleges.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF ENGINEERING DRAWING

W. J. LUZADDER, *Editor*
Purdue University

Professor Frank H. Heacock, Chairman
Engineering Drafting Committee of
The American Society for Engineering Education
Princeton University
Princeton, New Jersey

Dear Professor Heacock:

With the ever-increasing amount of technical knowledge that is developing in the modern world, it is inevitable that engineering colleges are continually studying their curricula to see how additional technical work can be included. In some cases, it appears that the fundamentals of engineering, on which sound engineering education is based, are threatened. It has been reported that several engineering colleges have reduced the amount of drawing to a dangerous minimum.

Representatives of industry often stress the importance of the basic subjects—mathematics, physics, chemistry, English, engineering drawing, mechanics—in the curriculum. After serious consideration of this attitude on the part of industry, and the trend of the colleges to reduce the basic training, particularly in engineering drawing, the following resolution was adopted unanimously by the Board of Directors of The Engineering Society of Detroit at their last meeting:

> RESOLVED, that The Engineering Society of Detroit advise the Engineering Council for Professional Development and the drawing division of The American Society for Engineering Education of its vigorous support of the retention of adequate training in Engineering Drawing in all engineering curricula.

We respectfully urge that The American Society for Engineering Education lend its support to our efforts to combat the trend of the colleges to reduce the basic training in engineering drawing, and thank you in advance for anything you can do toward the attainment of this worthy objective.

Very truly yours,

FRANK G. HORTON,
Managing Director

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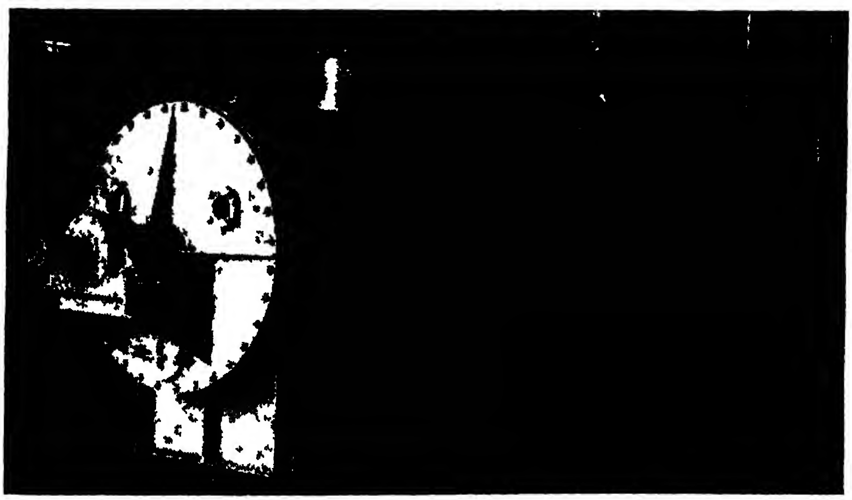

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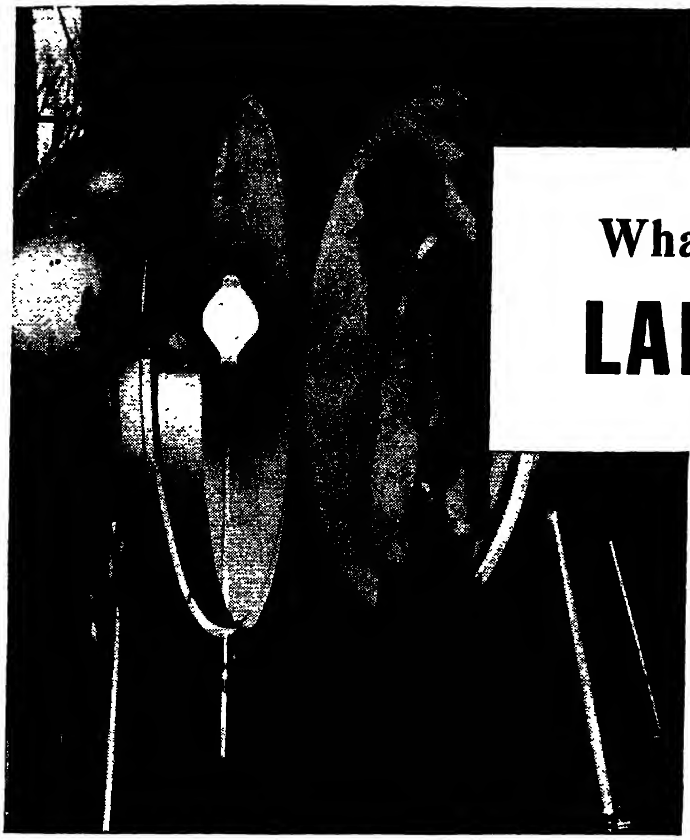

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A Westinghouse engineer in the lamp research department would visualize the 10,000 types and sizes of lamps the company makes. Standard incandescent and fluorescent. Heat lamps. Mercury vapor and fluorescent sun lamps. Bacteria-killing Sterilamps*. Talking lamps. Lamps to provide black light. Non-seeing mercury vapor to create photochemical reaction. The new quartz tube filled with krypton with a brilliance nine times greater than the sun. On and on. And others still to come.

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ANNUAL MEETING—UNIVERSITY OF WASHINGTON,
Seattle, Wash.—June 19–23, 1950

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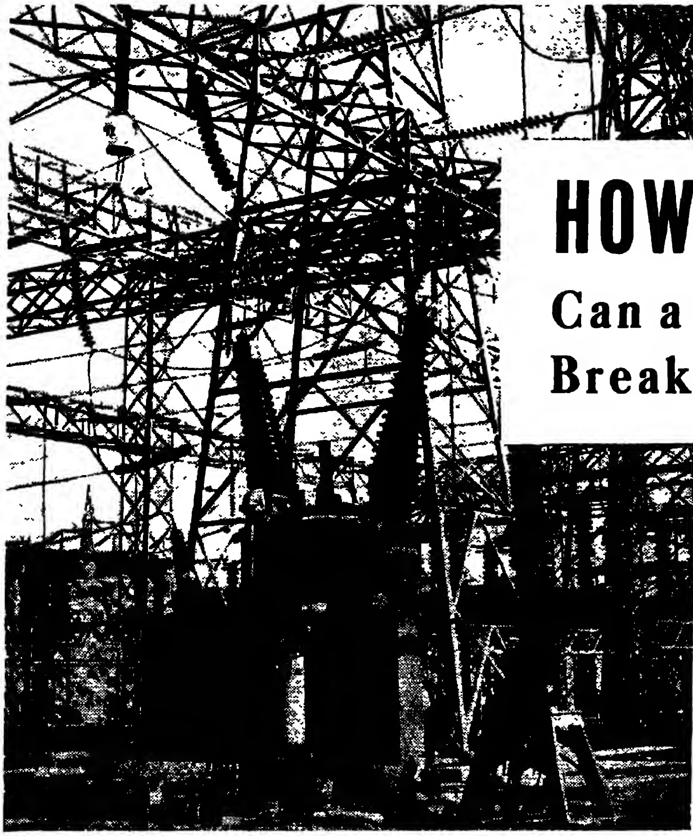

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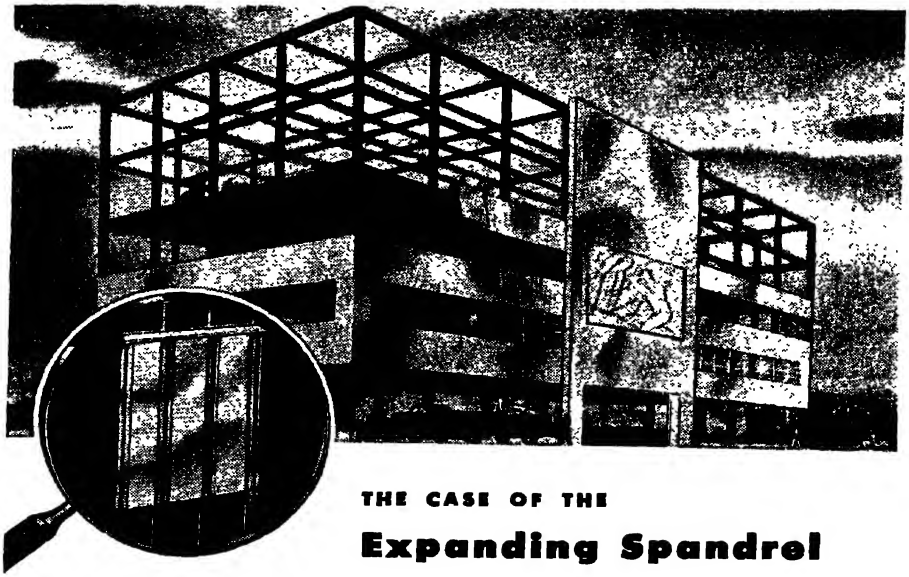

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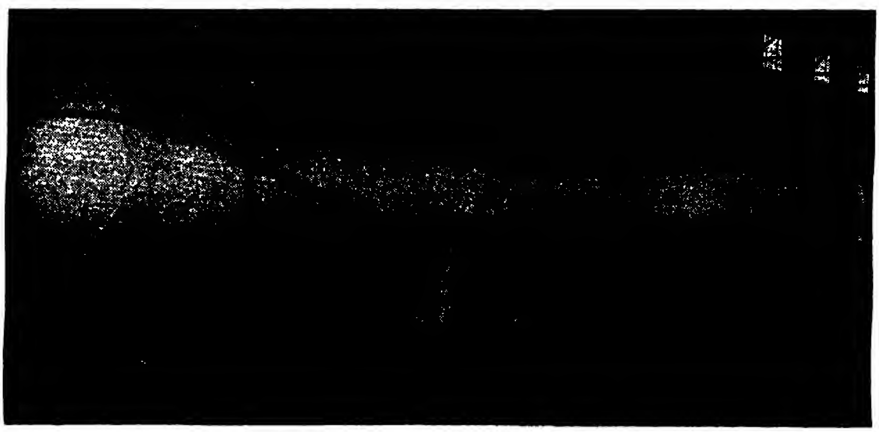

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The Yardstick of Quality

By F. M. DAWSON

Vice President of the ASEE and Chairman of the Engineering College Research Council
Dean of Engineering, University of Iowa

After many long and often fruitless discussions about the importance of differentiating *basic* from *applied* research, it is refreshing to read the remarks of President J. L. Morrill in opening the Symposium on Engineering Research at the University of Minnesota in March, 1949. "I have very little interest in the ancient argument over basic and fundamental versus applied research," said President Morrill.[1] It poses, he continued, an unrealistic problem—and he noted Arthur Morgan's "rather brusque remark that when a scientist expresses unconcern for the usefulness of research, he means simply that he does not accept current appraisals of its value."

There are, then, criteria other than "fundamental" which may far more effectively be used to select research problems most suitable for study in colleges and universities.

One such criterion would seem to be the *newness* of the research problem and the unpredictability of its direction and probable results. There is no great educational or scientific benefit in merely repeating an experiment already described by others; nor is there real educational benefit to be derived from routinely testing 999 vacuum tubes statistically taken from a factory's output. The value of research to an advanced student is primarily his lesson in how to go about learning things which have never been learned before. It is well for us all that, by the very nature of this educational process, students and their guiding teachers contribute new knowledge valuable to the nation and its industries.

To some extent, size may also be a helpful criterion in selecting research projects for the attention of educational institutions. When any research program becomes large and complex, it may become the tail that wags the dog. As Dean T. K. Sherwood pointed out before the Engineering Division of the Association of Land-Grant Colleges and Universities in October, 1949,[2] under such conditions there is a real possibility that educational goals will be subordinated to research goals. Colleges and universities are *educational* institutions.

Some research projects, too, can be judged by the people who are at work on them. When a project requires the attention of full-time research people over a long period, there is the likelihood that both faculty and students are being deprived of valuable part-time research experience. This is not to say that faculty and students should do routine and mechanical work on any project; there are ample grounds for making full-time technicians available. The goals of a university are not served by assembling numbers of scientists and engineers who take no active part in the institution's educational program and academic life.

At the Engineering College Research Council's Annual Dinner at the Rensselaer Polytechnic Institute, Dean A. F. Spilhaus described the essential difference between industrial research and university research in terms of the yardsticks applied.[3] Industrial and commercial organizations must measure their research in terms of both quality and potential profit, he said. Universities are

in the fortunate position of needing only the single yardstick of quality.

This would seem an excellent standard by which educational institutions and their faculties may gauge their performance of scientific research in the light of their very real opportunities and obligations. The aim should be to have really good research projects at each College of Engineering rather than have the work concentrated at a few institutions.

REFERENCES

1. Address of Welcome to the Symposium on Engineering Research, *Proceedings* of the Symposium, Bulletin No. 29 of the University of Minnesota Engineering Experiment Station, August, 1949, p. 3.
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College Notes

Ayer Hall, a new $500,000 College of Engineering building at the **University of Akron** was dedicated October 21, 1949, by holding open house, unveiling a portrait of Dean Emeritus Frederic E. Ayer and a dinner meeting at which A. A. Potter, Dean of Engineering at Purdue University, addressed educators, industrialists and alumni. A total of 40,000 square feet of floor space is provided on four floors and the building houses the departments of Civil, Electrical and Mechanical Engineering, with the exception of several laboratories, and the Mathematics Department. While the University is a municipal tax supported institution, the building was financed by donations from Akron industries and alumni. It is the second building to be completed under the present expansion program.

The new head of the Department of Mechanical Engineering at **Michigan State College** is Leonard C. Price, a member of the MSC staff since 1942. Prof. Price, who received B.S. and M.S. degrees from Cornell University, served as instructor at Cornell 1922–26; research associate at the University of Arkansas 1926–38; and as associate professor at the University of Arkansas from 1938 to 1942.

Frederick D. Rossini, Chief of the Thermochemistry and Hydrocarbons Section of the National Bureau of Standards, has been appointed Professor and Head of the Chemistry Department at **Carnegie Institute of Technology**, President Robert E. Doherty announced.

Vacation Possibilities of the Northwest

58th Annual Meeting
University of Washington
Seattle, Washington, June 19–23, 1950

By RALPH GANO COWLES

Humanistic Social Studies Department, College of Engineering, University of Washington, Seattle 5, Washington

The A.S.E.E. convention, scheduled to open June 19, 1950, at the University of Washington, offers a splendid opportunity for an extended vacation in the State of Washington, in Canada, and in Alaska. The Pacific Northwest is an "Evergreen Playground" where the vacationer will get his "money's worth and see everything there is to see." Less than ninety miles north of Seattle, Canada offers infinite vacation possibilities. An air trip to the heart of the Alaska country is both fast and inexpensive.

By the use of alternate routes on the trip to and from Seattle, the vacation traveler may visit many of the West's most scenic spots. The northern trip will take the traveler through the Dakota Badlands to Wyoming and Jackson Hole. From there he will visit the Rocky Mountains and Yellowstone Park. From Yellowstone the trip winds through Montana and the hills of Idaho to the eastern border of Washington. The southern route is traced through Colorado and Utah, through the southern limits of Idaho and the eastern boundaries of Oregon, with a long and beautiful drive down the Columbia River to Portland.

Before setting out on a trip to the Northwest the tourist would be well advised to visit his favorite service station for information concerning the travel guide services provided by the various oil companies. The larger companies furnish, free of charge, complete map service indicating the best places to make stopovers and the most outstanding sights along the various routes.

Grand Coulee Dam

Eastern Washington is world-famous for the giant dam at Grand Coulee. Completed in 1942, this dam is located at the head of Grand Coulee, a chasm 52 miles long and 1½ to 5 miles wide, in a geological wonderland only 92 miles from Spokane, the capital of Washington's "Inland Empire." Damming the mighty Columbia, the second largest river in America, the project supplies much needed power and water for the vast Columbia Basin Irrigation Project. During the war the dam's power output rose to a maximum of 962,000 kw. By 1948 the West Powerhouse with its full installation of nine generators could develop a peaking capacity of 1,125,000 kw. of electric energy. Primary, or firm, power may reach 9,000,000,000 kwhr. annually. This grand engineering achievement is indeed a "must" on the vacation traveler's itinerary.

The air-minded traveler will miss much of the pleasure to be gained by motoring through the country; but he will have ample opportunity to make up for it in side trips out of Seattle, the heart of the Northwest's Cascade and Olympic Mountain playground, into the numerous lakes and vast reaches of salt water that fill the Puget Sound Basin. Travel by air

to Seattle is swift and easy from almost any point in the Americas. The airlines flying into the Seattle-Tacoma airport at Bow Lake provide special vacation rates for family groups which compete successfully in cost with other types of transportation. Daily flights out of Seattle bound for Alaska and the Orient are included on the special vacation rates.

North of Washington lies the westernmost province of Canada, British Columbia, with its beautiful city of Victoria reflecting the spirit and glory of old England in the "bobby" on the corner and in the formal gardens surrounding the many beautiful buildings. Both Vancouver and Victoria offer the tourist British and Canadian manufactured goods at reasonable prices. The devaluation of the British pound sterling may result in many worthwhile bargains in English bone china and Scottish Tweeds.

The traveler intending to visit Canada should bring in his billfold documents such as his birth certificate or voter's registration card, as proof of his U. S. citizenship. If he plans to take his car, an insurance-liability card will make it easy for him if he forgets where he parked it and has it picked up by the Canadian Mounties.

Trips to the North Country

Those who plan to spend some time in the Canadian wilds may wish to make an extended trip to Lake Louise and the internationally famous resort at Banff, some three hundred miles north and east of Spokane. The best highway is out of Spokane through Bonners Ferry, Idaho.

Daily flights from Seattle to Alaska can be made for as little as seventy dollars, plus tax, to points on the Alaska coast. A flight to Anchorage will bring

Photo by Josef Scaylea.

Skies may be sunny and the evergreens throwing shadows across the highway but Mount Rainier presents a snow-capped picture the year around. Here's how Rainier looks from Chinook Pass on a sunny afternoon.

the traveler close to some of Alaska's trackless wilderness. Travel in Alaska is largely by air.

Those who wish to sail to Alaska via the Inside Passage should write to the Seattle Chamber of Commerce for information concerning the charter boats which make the trip each year. Reservations must be made very early, since the boats are limited in size. The Inside Passage to Alaska is used each year by many small-boat operators who fish in Alaskan waters.

Shorter trips out of Seattle to Mt. Rainier and Mt. Baker, for mountain climbing and hiking, are easily arranged. Mt. Rainier National Park is only 90 miles from the Seattle city limits. Snow-crowned, the mountain, towering 14,408 feet, is the second highest in the United States.

The traveler may make an extended trip around the Olympic Peninsula and through the Olympic National Park, one of the wildest regions left in America. Near the extreme northern end of the Peninsula lies Lake Crescent at the foot of Mt. Olympus. The wilderness of this section of the peninsula is penetrated only by hiking trails. Lake and stream fishing is perfect, in this naturally beautiful setting.

Fishing trips in Puget Sound may take the vacationer up the Sound from Seattle to the many San Juan islands which are dotted with resorts and cabins available to the summer visitor. Many of the islands have excellent beaches, though the Sound water is too cold for a very prolonged swim. Boys' camps and summer camps for girls are located on some of the islands of the San Juan group, providing outdoor life in rugged terrain with the natural beauty of the Northwest at its best.

Seattle Offers Variety

But the convention vacationer need hardly go beyond the city limits of Seattle to enjoy a thrilling and highly educational summer. Once called the last jumping-off place of civilization, Seattle still retains much of the glamour and many of the landmarks of the old days of the Alaska Gold Rush. Despite the conquest of the giant timber growth, many Douglas fir and Red Cedar still cloak the slopes of the Cascades and Olympics which guard Puget Sound. Situated on the western shores of Elliott Bay, an arm of Puget Sound, Seattle is almost surrounded by water. On its east side lies Lake Washington, a fresh-water lake almost twenty-five miles long and four miles wide at several points. Green Lake, Lake Union—in the heart of down-town Seattle—and Lake Washington provide many Seattle residents in their hilltop homes a view of one of the lakes.

Lake Union provides moorage for hundreds of houseboat homes along its shores. Out in the deeper waters of the lake are moored many deep-sea boats; these have been towed into the lake by powerful tugs from Elliott Bay through the ship canal constructed between the bay and the lake with a system of locks second in size only to those in the Panama Canal. The ship canal also extends into Lake Washington, making available many miles of moorage and docking space which gives Seattle the distinction of having more small boats and pleasure craft per capita than any other city in the world.

Boat races and regattas are held each week during the summer. Hundreds of spectators crowd Lake Washington's unique floating bridge to view the boat races. The city has three yacht clubs, and the competition between the various boat owners is keen. Many boats are available for charter by the day or week. The vacationer may also take scenic rides on ferry boats to interesting points on the Sound. A typical one-day tour of Seattle's waterways starts at the dock in downtown Seattle and threads through the Sound to the lake and back.

Seattle, of course, is famous all over America for its fine seafood. Many fine restaurants specialize in Dungeness crab,

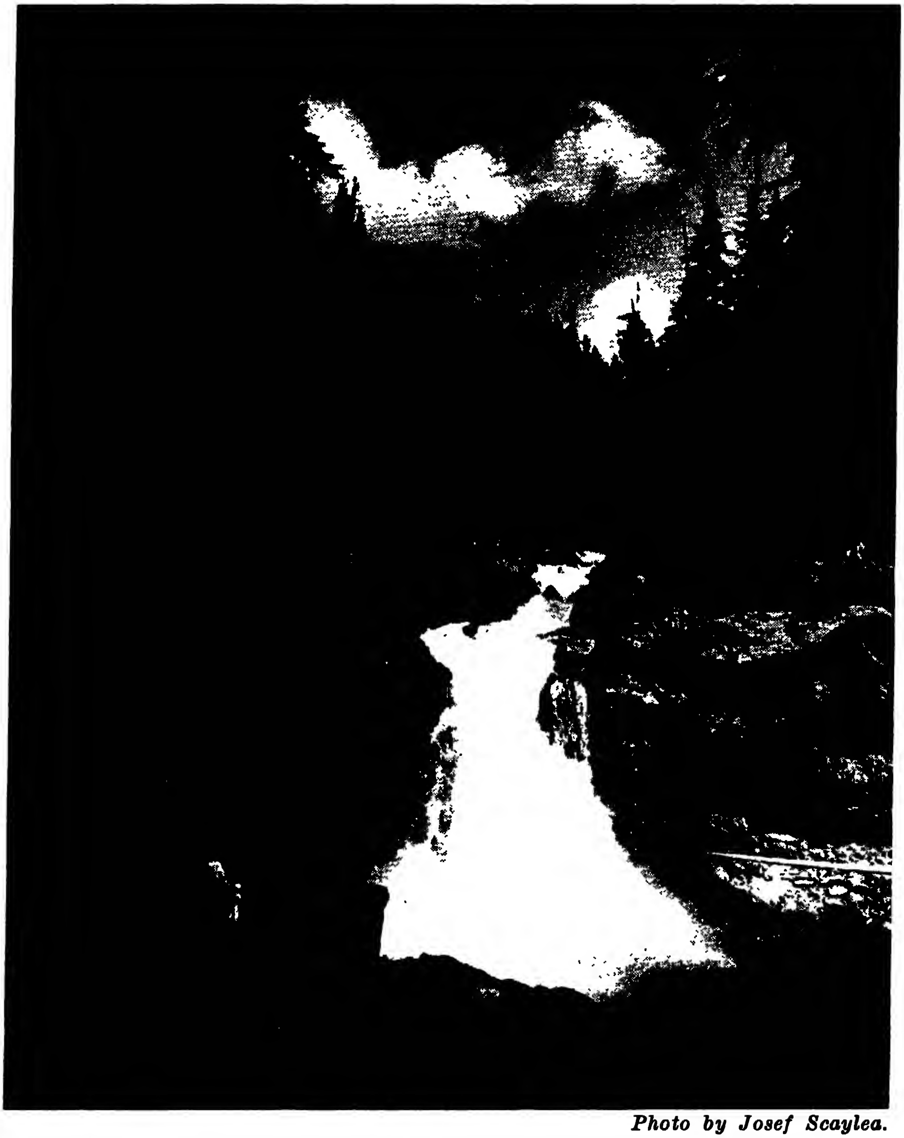

Photo by Josef Scaylea.

A breathtaking sight is this view of Silver Creek Falls in Rainier National Park. Ribbon-like, the mountain stream winds its way through trees and underbrush to crash to the rocks below.

Olympic oysters, and fresh salmon, served variously in all the fine eating places in the Northwest.

Seattle's Chinatown is perhaps not as well known as that of San Francisco, but the Chinese restaurants provide the finest in Chinese-American food.

The Seattle Art Museum, at Volunteer Park, has one of the few outstanding collections of Chinese and Japanese art in the world. This collection is displayed each summer as an attraction for the thousands of tourists who visit the Northwest.

Many dark things have been said about Seattle weather, but on the average the "sunny days" compare favorably with the best weather of other states, and although rain does fall, most Seattleites would deny that "it is always wet." On the whole, summers are cool, with few cloudy days during the months of June, July, and August. The traveler planning to spend the summer months in the Northwest should bring clothing appropriate for cool nights and warm days. A light topcoat for evenings often seems desirable to persons coming from warmer climates.

No bears now roam the campus, no Indians hunt scalps, but the Pacific Northwest still offers its guests the traditional western hospitality.

Those who plan to spend a few weeks vacationing in the West after the close of the annual meeting would do well to write (a) the Seattle Chamber of Commerce for further recreational possibilities and information on housing, (b) the Alaska Steamship Company, Seattle office, for reservations, which must be made well ahead of time, and (c) the Alaska-States Air Travel, Inc.

The Canadian Pacific Railway has a ten-day cruise leaving Vancouver on Saturday evening, June 25, and returning to Vancouver on Tuesday morning, July 5. The Cruise is up the Inside Passage to Skagway and stops are made at intermediate points. The minimum cost of this cruise is $184 including tax and meals. Reservations should be made before the end of January. They may be obtained by writing directly to Mr. C. C. Jordan, Canadian Pacific Railway, 1320 4th Avenue, Seattle, Washington. The railroad trip from Seattle to Vancouver takes about 4½ hours.

The Alaska Steamship Company offers twelve day cruises to Seward, Alaska. The minimum cost is approximately $228 for a lower deck room, including tax and all meals. Requests for reservations should be addressed to Mr. K. A. Cross, Assistant General Passenger Agent, Alaska Steamship Company, 823 2nd Avenue, Seattle 4, Washington.

College Notes

Succeeding Dean and Director M. L. Enger, who after forty-two years of service to the **University of Illinois** reached retirement age this summer, Professor William L. Everitt became head of the College of Engineering and the Engineering Experiment Station on September 1. He was succeeded as head of the department of electrical engineering by Dr. John D. Ryder, professor and assistant director of the Engineering Experiment Station of the Iowa State College. Other new appointees include Professors Frederick Seitz and James H. Potter, 4 associate and research associate professors, 8 assistant and research assistant professors, 15 instructors, and 2 special research associates, besides 46 research assistants and 50 non-research assistants.

Maintaining Our Industrial Leadership Through Engineering[1]

By M. E. COYLE

Executive Vice President, General Motors Corporation

Dr. L. W. Houston, President of Rensselaer Polytechnic Institute, has spoken of the need for better understanding and closer relationship between industry and the colleges, particularly those engaged in engineering education. The degree of financial responsibility of industry to educational institutions has never been clarified. But there are many concerns at the present time making specific grants to schools in connection with research work which applies to their particular activity. This list is rapidly increasing, both in number of participants and amount of funds assigned.

Industry, as well as the colleges, has certain objectives and a share of the problems. We who have served many years in industry and have participated in its expansions should be able to draw upon our experience and offer counsel as to how the objectives may be achieved and some of the problems solved.

The industrial leadership that we have attained and which we are desirous of maintaining and expanding, was not accomplished by engineering alone. We know that engineering has made a major contribution and that without it we could not have reached our present position. However, engineering needed the support of an efficient production department, as well as a capable distribution organization to make the products available to the customers on an even-flow basis. Most important of all was the role of the money invested in the enterprise by the stockholders under what we call the free enterprise system and the American way of life.

As a matter of fact, we have possibly abused the free enterprise system and American way of life terminology to some extent. It simply means the right of every individual to make a financial investment of his own choice—the right to lose his shirt if he invests unwisely—the right, and always the hope, of an increase in the value of his capital and some return in the form of dividends if he is more fortunate.

I have seen many stimulating influences and also recognize many that are retarding the development of industry. If the present trend is continued, I am afraid there is trouble ahead of us. To cover these points adequately I must speak on a broader basis than the title of my talk as given by your Chairman would indicate. We are interested in more than the maintenance of industrial leadership. Dean Freund wrote me under date of March 9th and said, "May I suggest you discuss any subject you choose which has to do with the positions and problems of the American industries and the automobile industry in particular." I am going to take advantage of his suggestion for the following reason.

Industry's Viewpoint

Last December a number of industrial concerns, including United States Steel,

[1] Presented before a General Session of the 57th Annual Meeting of the ASEE, Troy, N. Y., June 21, 1949.

General Electric, General Motors and several others, were requested to appear before a Congressional Committee in Washington and supply information in respect to prices and profits. The attitude of the committee in regard to the size of the corporations and the amount of their profit came as a distinct surprise. During our appearance for General Motors the Committee highlighted the position of leadership attained by General Motors during the forty-one years of its existence, following its organization in 1908. They stated that General Motors had reached its present position honestly and in an open competitive market; that it had not done so by having control over limited natural resources.

They stated, however, that General Motors was too big and must, therefore, be put under some sort of control. They concluded their comments by stating that it was a problem with which the Congress would have to deal in a manner that was not at the moment entirely clear.

Subsequently, the May issue of *The Nation's Business* carried an article by Senator Flanders, Chairman of the Committee in Washington, in which he referred specifically to part of the testimony given by General Motors. In the April issue of *Reader's Digest* was an article by Senator O'Mahoney, another member of the Committee, referring to the bigness of industry. On the floor of the Congress, Representative Helen Gahagan Douglas of California made the following statement: "One year's earnings after taxes of one corporation, General Motors, doubled the assets of the 32 major labor unions in the whole country . . . which must provide protection for 8 million people . . . less than 28 pitiful dollars per person."

All of these comments follow a similar pattern and while we feel that Congress will not legislate against General Motors specifically—whatever laws are passed will apply to all corporations—they do indicate a retarding influence in respect to the development and expansion of industry. It is this trend that indicates there is trouble ahead of us unless the trend is reversed. Government should encourage, not discourage, industry.

During the Washington hearing the statement was made on several occasions that profits of all United States corporations in 1948 exceeded 20 billion dollars. Some of the witnesses questioned the accuracy of these figures. Reference was made to the influence of inflation, the lessened purchasing power of the dollars which would reduce the value of these so-called profits. Others directed attention to the allowable depreciation rates being inadequate to permit replacement of capital facilities at current costs. I do not feel the accuracy of the figures is at all important. What I believe to be important is the fact that the reported profits of all United States Corporations for 1948 are less than half the Federal budget now before Congress and which the present administration proposes to spend during the next fiscal year. It is extremely important to realize that our country cannot afford to spend 42 billion dollars in any peacetime year.

Large Corporations Are Indispensable

As to the size of corporations, our recent experience in World War II should indicate that the greatest productive asset of our country was the large corporations. They could accomplish so many things that never could have been done by smaller business concerns. I am convinced that the Allies could never have won the war without the production facilities and products of the United States Steel Corporation. I do not believe the war could have been won without the production of General Motors and certainly it could not have been accomplished without the support of the automotive industry.

General Motors alone made over 206,000 of the airplane combat engines that were used in World War II. It sold to the Allies more than 12 billion dollars worth of war materiel at a mark-up of less than half of the peace time rate over cost. The United States sent on Lend-

Lease 11 billion dollars worth of materiel to Russia. If the Russians had had one General Motors they would not have needed Lend-Lease.

A great part of our industrial progress has occurred in the past fifty years. We have capitalized the inventions of the preceding century. Our population has doubled in those fifty years and now totals 150 million people. We must not assume that all of our modern conveniences were always available. Most of them are of recent origin and all have been improved in quality and lowered in price. Our nation is only 160 years old, actually only a moment in the passage of time. Dealing only with the essential items, it is important that we trace the industrial development which has occurred during that period and its influence upon the prosperity and living standard of our people.

Phenomenal Progress Under Private Enterprise System

In 1800 George Washington had completed his two terms as President. John Adams was completing his single term and in the fall of that year Thomas Jefferson was to be elected. Our country was comprised of the thirteen colonies, located along the Atlantic seaboard and extending from New Hampshire on the north to Georgia on the south. The population of the country was 5,300,000. Florida was owned by Spain, Louisiana by France. After the Louisiana Purchase in 1803, this territory, which extended from Canada to the Gulf, lying west of the Mississippi River, was divided into nine of our present states and some parts of four others. Texas, New Mexico, Arizona, California, Utah and Nevada were all acquired later from Mexico.

Transportation and communication were practically the same as they had been in the time of Christ, some two thousand years before. James Watt had developed the steam engine and had taken out patents in 1775. But up to 1800 it was used exclusively for pumping water out of the mines in England.

During the next 70 years the country developed and expanded, taking in most of the territory we now look upon as representing the United States. The population increased to 38.5 million people. There were relatively few inventions in that time in relation to what we know today, although those that were made were extremely important. Steam was applied to both water and rail transportation and was used, to a limited extent, in supplying power in factories. However, the power had to be transmitted to the machines through line shafting and belting and was, therefore, not adaptable on a wide scale.

The principal inventions were the vulcanizing of rubber by Goodyear in 1839. In 1844 Morse sent the first telegraphic message, in 1851 Daguerre developed the first sensitized photographic plate. In 1866 Cyrus Field laid the first Atlantic cable and in 1867 Pullman invented the sleeping car.

During the next thirty years, ending in 1900, our population increased to 75 million people and the inventions of that 30-year period exceeded in importance all that had been made in the prior centuries. The living conditions which we accept as normal today would not have been possible without them.

In 1876 Alexander Graham Bell invented the telephone. In the next year Edison invented the phonograph and in 1879 the electric light. Then, in the ten years between 1880 and 1890, the world was given two new forms of manufactured power—the electric motor and the internal combustion engine. From the beginning of time up until the invention of the steam engine by James Watt, the only forms of power were the energy of man, beast, wind and water. Steam rendered a limited source of energy for a period of 100 years and then, within one decade, we developed two new forms that have completely revolutionized industry and our civilization.

In 1893 the kinetoscope, the basic in-

vention of the motion picture, was developed by Edison. In 1894 Roentgen invented the X-ray and in 1896 Marconi invented the wireless telegraph. These were the outstanding inventions during this period of thirty years.

It is difficult to realize the progress that has been made in transportation, communication, manufacturing, distribution and industry during the past fifty years and in this progress engineering has played a very important part.

Our aviation industry represents the greatest progress in transportation. On June 10th of this year a Detroit paper carried an interesting column in which the author described her experience in boarding a plane as the sun was rising over Paris, stopping at Shannon and Gander and arriving at Willow Run Airport in Detroit one hour before sunset. Paris to Detroit in the daylight hours of a single day! Let us look back to December 17, 1903.

On that date the Wright Brothers made the first successful mechanically powered airplane flight at Kitty Hawk, North Carolina. They made four such flights. The first lasted twelve seconds, the second and third were longer, while the fourth lasted fifty-nine seconds and covered 853 feet against a twenty-mile headwind.

Compare 853 feet in 59 seconds forty-five years ago last December with the speeds of the supersonic jet-propelled planes of today—speeds that exceed 2000 feet per second. The improvement of the internal combustion engine by the automotive industry made the progress of aviation possible.

An important advance in communication has been accomplished by the telephone. In 1900 the telephone was limited in number of instruments in use as well as in distance over which it could be used. Now we can talk to any of the principal cities in the world and to most of the ships at sea. Adapting the principle of wireless telegraphy discovered by Marconi made this possible and was subsequently expanded into radio and television. Few people realize the first radio broadcasting station was opened in Pittsburgh in 1920, less than 30 years ago. We now have 75 million radio receiving sets in 40 million homes. Television is available to nearly 67 million people, even though it is relatively new as an industry. It was the investment of private capital and the intelligent management of industry that made this progress possible.

Since 1893 the motion picture industry has been developed to a point where there are 18,000 theatres with a capacity of 12 million seats. The employment made available through the production of cameras and film and in the distribution and showing of the pictures is another illustration of the importance of investment of private capital.

The Automotive Industry

The automotive industry has shown the greatest growth and is responsible for the employment of one out of every seven workmen. This industry started with the building of the first successful internal combustion engine in 1887 and its application to the first gasoline powered automobile by the Duryea Brothers in 1893. The number of vehicles produced prior to 1900 is not known as no records are available. Production in 1900 was 4,192 units and in August, 1948 the industry produced the 100 millionth vehicle.

Where the risk is great the opportunity for profit must be equally great to attract the required investment of venture capital. Since 1900 more than 1850 different automobile producing companies entered this highly competitive field and today there are 54, a mortality rate of 97 per cent.

General Motors has been specifically referred to by the Committee in Washington and on the floor of Congress. We who are associated with General Motors are proud of its record, its size, and of the contribution it is making to a better living standard of the nation. While complete annual statements are issued,

there are essential facts that should be stressed.

General Motors is best known for its production of passenger cars and trucks, but it also produces 750,000 fractional horsepower electric motors per month, refrigerators, radios, washing machines, diesel electric locomotives, approximately 70 per cent of the aviation jet engines produced in this country, and many other products. We employ nearly 400,000 people, buy from 12,400 sources of supply, sell to more than 16,000 automotive dealers, plus thousands of outlets for our other products. The company is owned by 430,000 stockholders who have invested two billion dollars in the business, including the 125 million borrowed from the insurance companies and for which the stockholders are liable.

The size of General Motors has been determined by the desire of our customers for the products we make, and our desire to satisfy consumer demand. Our sales at wholesale in 1948 were 4.7 billion dollars. The dealers, and their more than 200,000 employes, resold these products at retail.

General Motors purchases of material and services exceeded 50 per cent of our sales, a total of $2,368,000,000, a large part of which was supplied by small business concerns. Big business could not operate without the support of small business, and small business could not survive without selling to the large concerns.

Wages and salaries cost $1,343,000,000. Incidentally, the entire General Motors payroll for 1948 was equal to the Federal Government payroll for the month of October, 1948. It causes us to wonder what the senators mean when they refer to the need of control of big business. Taxes were 694 million dollars and that left 440 million in profits for the stockholders, of which 211 was paid in dividends and the remainder of 229 million was reinvested in the business.

To clearly understand the result of General Motors operations for 1948, these figures should be related to each other. The stockholders who own the business and furnish the money that makes the enterprise possible, and who also assume all risk of financial loss, received an aggregate of 211 million dollars in dividends and their equity in the business was increased by 229 million of reinvested earnings, a total of 440 million.

Federal, State, County and City tax authorities collected 694 million dollars, more than 150 per cent of the amount earned for the stockholders, and more than three times the amount the owners received in dividends. Payrolls were three times the total stockholders earnings and six times the dividend payments, yet General Motors was called to Washington to testify as to its prices and profits, and told that its size "poses problems with which this Congress will ultimately have to deal in ways I cannot foresee at present."

Let us clarify the stock ownership of General Motors, and its experience is typical of most industrial corporations. There are 140,000 stockholders who own 10 shares or less of General Motors stock. There are another 180,000 who own more than 10 and less than 50 shares. Of the remaining 100,000 stockholders, many are insurance companies, investment trusts and charitable organizations, in which many people have an interest. In other words, big business is a combination of a great many small people who have joined together to make an investment, and these small investors have the benefit of the wisdom, business experience and management capacity just the same as the heavy stockholders. They are participating in all the benefits in proportion to the number of shares they own.

Government is Discouraging Industrial Expansion

The present attitude of Government toward Industry, together with excessive taxes, has discouraged the investment of savings as venture capital. It is difficult for large concerns with a good earn-

ing record and proven management to secure new capital or long term loans required to meet the expanding needs of the business. In speaking of Governmental attitude, I do not distinguish by party, Republicans, Democrats, New Deal, Fair Deal or Dixiecrats. I am referring to political expediency and honesty in political administration.

The expenditures of our Federal Government from the inauguration of George Washington on March 4, 1789 to the end of 1918, a period of 130 years, were 41½ billion dollars. This included the cost of the war of 1812, the Mexican War, Civil War, Spanish-American War and the years of 1917–1918 of World War I. Our present administration is requesting 42 billion dollars for the next fiscal year, and World War II has been over nearly four years.

Following World War I the Federal Budget averaged less than four billion annually, one-tenth of the present level. In those years the Government had 560,000 employes, now it has 2,100,000.

There is currently before the Congress a proposal to spend 10 billion dollars for socialized medicine. Another proposal is a farm program which will cost 10 billion dollars. Then there is a bill providing for the expenditure of 20 billion dollars over a twenty-year period for Federal Housing. I am convinced that the amount, if the bill became law, would be substantially increased and the period of expenditure would be reduced. In each of these cases the group that would benefit would have to sacrifice their freedom in order to participate. The farmer would have to agree as to the type of crop he would plant, acreage to be planted and to comply with price regulations when marketed. The Government has established a routine of confiscating our savings by excessive taxation and buying, with our own money, certain voting segments.

The following statement by General Eisenhower in reference to the bill for Federal aid to Education sets forth the danger we face in all these cases. General Eisenhower said, "Unless we are careful, even the great and necessary educational processes in our country will become yet another vehicle by which the believers in paternalism, if not outright socialism, will gain still additional power for the Federal Government. The army of persons who urge greater and greater centralization of authority and greater and greater dependence upon the Federal treasury are really more dangerous to our form of government than any external threat that can possibly be arrayed against us." General Eisenhower is entitled to the thanks of the country for drawing attention to the danger of central control, which has already progressed to a dangerous degree.

I am particularly gratified to have a place on your program and for the opportunity to speak frankly to you on this subject of mutual interest. You have an extremely important assignment in the education of 240,000 young people who have chosen the engineering profession for their life work. They are being trained under your supervision. Unless industry can successfully expand and develop in the future as it has in the past, these young people will have little hope for the future except as replacement for older people and your work will have been futile. Your interests and ours are parallel. We are interested in the welfare of our country. We want our economy to grow and expand and this nation to be a good place for our children, and our children's children, as it has been for us.

Popular Reactions

Recent happenings have indicated the power of an aroused voting public. The passage of the Reorganization Act of 1949 came as a result of a flood of letters, telegrams and ballots that were sent to the Congress. The same result can be secured in respect to taxes if similar demand is made.

Referring again to our experience in Washington last December, the question

was directly asked as to our recommendation as to sources of additional tax revenue to permit continued governmental expenditures at the prevailing levels. Should normal rates be increased, excess profits reestablished, or a graduated scale adopted for corporations similar to individual income tax rates? The implication was given that the November 21, 1948 election was a mandate from the people to continue the policy in effect.

In respect to taxes, no corporation pays a tax. All taxes are paid by people. If a corporation fails to recover all cost, including taxes, in the selling prices, they are distributing their capital with each sale, and if continued long enough and on a sufficient number of transactions, the concern will be liquidated. It should be obvious, therefore, that taxes imposed on corporations are passed on to the customers or borne by the stockholders, all of whom are people.

The last election was far from a mandate. There are 94 million people in this country who are eligible to vote. Sixty-seven million of them registered, 48 million voted, and 24 million voted for the incumbent administration. When the electorate of this country does not like the wasteful extravagance of Government they will change it by demanding a reduction of taxes and a return to the principle of free enterprise that made this country great.

Our task, and our responsibility, is to place before the people a clear understanding of the prevailing trends. There are 92 million people in this country who were not born or were less than 21 years of age when Franklin Roosevelt was inaugurated in March of 1933. They have never known any type of Federal administration except Federal control.

I am convinced that many people will feel that the things I say—and what is being said by most industrialists—are self-serving. After all, it is my country just as it is yours and I have a perfect right to express my opinion. I want to thank you for having had the patience to listen to me.

Professional Guide for Junior Engineers

This 56-page publication, issued by the Engineers' Council for Professional Development, was written by the late Dr. William E. Wickenden, and edited by G. Ross Heninger.

The book seeks to give the young engineering graduate a sense of professional values in chapters on engineering origins and professional relationships. Full treatment is given to the practical side of getting an engineering job and of advancing in the profession. Also included is the Council's credo "Faith of the Engineer," a self-appraisal questionnaire, and the Canon of Ethics for Engineers.

The price is $1.00 per copy (25% discount on 10 or more copies). Send orders to Engineers Council for Professional Development, 29 W. 39th St., New York 18, N. Y., and enclose remittance.

Problems of Training the Engineering Student for Citizenship[1]

By CHARLES E. MACQUIGG
Dean of Engineering, Ohio State University

For the purpose of the present discussion the personal qualities required for good citizenship are assumed to be: first, character; second, intelligence; third, competence in the line of contribution to the material welfare of society. These are placed in their proposed order of importance. It is the present purpose to discuss the first criterion only and for that reason it is proper to first dispose of the second and third.

Intelligence is here defined loosely as the quality believed to be chiefly a matter of inheritance and as a fundamental quality of personality about which little can be done. It may be that this viewpoint will be very offensive to the behaviorist and a final decision must be left to more competent authority; in any event, it is assumed that little can be done to add to the sum total of the intelligence factor of personality in a college education. We do, however, add to the effectiveness of an intelligence by processes which aid the acquisition of useful facts, and to that minor extent we do make some contribution.

The attribute of competence is taken to mean the skill and experience of the individual and these naturally integrate into his other qualities to make him a more desirable and productive citizen. These factors seem to be too obvious to require elaboration; moreover, it is generally believed that the educators of the engineer have done an acceptable job in this area, or at least as good as may be expected taking due account of the attributes involved in faculties and students. (Lest we fall into any kind of smugness on this score, however, we must continually examine our curricula and staff, making every effort to utilize all of the machinery of teacher training (including personality assays); visual aids, and any other ways to increase our efficiency.)

Character Development

Dismissing thus two of the three assumed attributes of good citizenship, what of the third, namely character, and what if anything can the engineering teacher do to help his students in this primary requirement of citizenship? Can we assume that character can be molded any more than we can believe that the intrinsic quality of the intellect can be raised? I think we can so believe. But let us first define what we mean by character. It is "A trait or characteristic, especially one serving as an essential or inner nature of an object or person." "That which a person or thing really is." "Moral vigor or firmness, especially as acquired through self-discipline." "Character endures throughout defamation in every form, but perishes when there is a voluntary transgression." In other words, character sums up those qualities of the spirit of the individual which shows in the types of action he exhibits—such as steadfastness, sobriety, liberality, cheerfulness, truthfulness, charity, and many others—with, of course, their opposites.

[1] Presented before the Humanistic-Social Division at the 57th Annual Meeting of the ASEE, Troy, N. Y., June 21, 1949.

It might appear to many that by the time a student has reached college age his character will be formed, but this is true only to a certain degree since most of us know of many exceptions and if we are frank, we realize the truth of this observation in our own experiences.

If we consider that the youth we are privileged to influence are still somewhat plastic, as it were, what is to be done? This brings up the necessity for being aware of and sensitive to the problems youth is facing on the average campus. No one can deny that the pressure of living has increased in the past two or three decades to levels beyond anything previously experienced in human history and the youth of today is beset by worries not experienced by mature men of fifty years ago. If the nature of the problems has not materially changed their insistence certainly has and also the tempo of their insistence. So, in touching upon a few of those college problems of today (which are equivalent to if not identical with those of John Q. Citizen) let youth speak for itself.

Survey of College Problems

A very recent survey at one of the large universities was made by questioning 601 men and 157 women students comprising those with various degrees of college experience—i.e., direct from high school; from high school via intervening work experience; and some by transfer from other colleges. About one-third were veterans with postwar short enlistments. A number were married and had children; most wives were working. The questions asked were chiefly along the lines of "adjustments" and embraced such areas as health, scholastic, financial, family and home, religion, moral, personality, social (such as friends, leadership, recreation, fraternities, etc.), living conditions (rooms, food, community relationships, etc.), outreach (cultural, hobbies, life plans, etc.). The survey showed the following:

Health generally good; need for keeping physically fit was generally recognized; food was a problem; worry and nervousness over studies, "tired feeling," loss of sleep, loss of weight were complained about; student Health Service was used.

Scholastic adjustments were quite severe. Large classes a special problem and consequent loss of individuality was a shock to many. Inability to take adequate notes was a severe handicap. In spite of these transitions, the consensus was not critical of the instruction; surprise was expressed at the efficiency of the teaching staff in general. There was a general feeling of surprise at the responsibility put on the student to "be on his own." [2] The problems of study facilities were noted as acute in dormitories, and ideal conditions noted in private homes. Grades are always "going to improve next semester."

With respect to finances, almost invariably the students find expenses heavier than planned for. Modes of living have to be adjusted to pocketbooks. The majority of all students and most of the women were entirely supported by parents; there is a feeling of nearly universal regret among the students at this dependency. Most veterans cannot live on their subsistence checks and in general the wives are working. Outside employment shows a high incidence with occupations varying widely—common laborers, bartender, skilled accountant, etc., etc. Outside work is frequently blamed for low grades and lack of participation in extra-curricular activities.

Social adjustments. Students living at home found little change—life going on pretty much as usual. Students away

[2] Information from C. W. Reeder, Junior Dean, College of Commerce and Administration, The Ohio State University. In the last analysis, isn't the success of a college student determined by his general ability to take over on his own responsibility? Those who learn this, if they have average mentality, will get through, but those who lack this ability will almost surely fail.

for the first time noted a marked difference in the imposition of the factor of "self-government." Week-ends at home are generally to be deplored, no matter what the excuse. Jewish students exhibit the closest ties with home. Veterans as a class are the most emancipated group; college is for them a continuing incident in life away from the parental fireside. Marriage greatly increases all responsibilities. Almost universal mention was made of the interest of parents in the children resulting in frequent letters and long distance phone calls.

Religious and Moral Standards

It was reassuring to learn that college life apparently introduces very little disturbance to religious backgrounds with little or no change in beliefs and denominational preferences. Jews and Catholics are most firmly rooted in their religious preferences with Protestants observing a "live and let live" attitude. Discussions on religious subjects are frequent and often heated, with little change of stand resulting. These debates give rise to an interest in religion and some students have been stimulated to visit other churches to get firsthand information. Church going is not the rule, the excuse being that Sunday is used for sleep. "Some comments were made concerning statements of University teachers. Some faculty men belittle religion, but others teach tolerance. Some show the relation of religious teachings to their subject fields. Many students said that their growth in knowledge had not changed in any way their religious beliefs."

Respecting moral standards, most students follow the patterns they learned at home, and college life gives them small reason to vary their standards. A tendency is greater among women than men to miss counsel of their parents. Such criticism as was noted was directed against behavior at social parties, particularly drunkenness.

Other Factors

"Students found it hard to discuss their own personalities. Some did note changes which had occurred under impact of University experience. The most common observation was the growth in independence. There was the need to make decisions on many matters, and no one to consult. Pleasure was expressed over the development of this characteristic."

Fraternities were praised for their improved living and study conditions over dormitories; social graces and ability to mix successfully were noted as advantages by those who were members. (Might some "unscrupulous" educator make a sly argument for broadening?) Criticism of fraternities was from nonmembers and was chiefly on account of the expense and social excesses.

"The students were very frank about their plans for marriage. No one, neither men nor women, planned to live alone. All look forward to homes and children. But all wanted an income sufficient to maintain a decent standard of living."

These are some of the problems that confront the students of today. What can the teacher in the college of engineering do, if anything, to help guide these young people who will make the society of tomorrow?

So much cogent advice has been spoken and written in the past few years anent the inclusion of the humanistic studies in the education of the engineer that further reference here would be mere reiteration. In this area we have a right to expect the best results in the broadening, enlightening and orientation of our students toward the implications of good citizenship; this orientation can come from the study of history, philosophy, sociology and similar disciplines. These fall outside the scope of the technical, but it seems that the teachers of technology have a duty and, what is more important, an opportunity to influence their students in as effective a way as do the teachers of the humanities.

Counseling Needs

There are many excellent reasons why few engineering faculties will be able to enter into any *formal* plan for the counseling and advisement of students in other than purely technical matters, the chief one being lack of time. But if the faculty member is aware of the adjustment problems of the students and is at the same time sympathetic and willing, the following are some of the ways in which aid may be extended:

1. Realization of his responsibility. Dr. Wickenden realized this in his philosophy of "The Second Mile." In counseling students, one repeatedly finds an element of wistful wishing on the part of the student that he might have been able to have had advice from a teacher at some critical time or other which might have helped him avoid a difficulty. The teacher in any subject who does not try to meet this need by making the real sacrifice of nervous energy entailed had better find another occupation.

2. Lack of sympathy on the part of any teacher seems to be the "unpardonable sin" from the students' viewpoint. Students may chafe under hard driving; high but difficult standards of performance may not at the moment be welcomed (although they are almost invariably recognized in later years and commended). But cynicism and sarcasm are always resented and never serve any useful purpose; even after long years of maturity the habitually sarcastic teacher is remembered as one who failed his objective even in an educational sense.

3. At this time in world affairs, an attitude of hopefulness is needed and we need not fear that our discriminating students will mistake it for narcosis on the one hand or naiveté on the other. If one of two choices were necessary, rather than sell this country and all humanity down the river of despair, it were better that we fall back on the philosophy of stoicism. But neither choice is alternative if we realize that most of our gloomy outlook at present stems from a rather personal selfishness. Just now we should compare the obvious good of today with the manifest ills of yesterday. Man has changed a little for the better in thousands of years, so give him time! What skeptic among us would go back even twenty-five years and trade *everything* in that day for life today?

4. No single one of us lacks frequent opportunities to advise with our students in an effort to reach a citizenry with reasonable optimism, with charity and justice, with tolerance, with always greater incentives to mutual helpfulness and a living desire to see the greatest good to the greatest number.

5. The students themselves are concerned about problems of ethics. Many of us may have opportunities to counsel groups on misconduct in examinations, on intemperance in social gatherings and other irregularities to which we cannot close our eyes and which are so obviously the actions of the few but by which the public measures the standards of the many. A leaven of wise counsel to fortify the resistance of the majority of upright student opinion will surely pay off in our future citizens.

These are some of the ways in which the teachers of descriptive geometry, or electronics, or English, or thermodynamics can help to prepare the engineering student for citizenship.

Efficiency and Cooperative Behavior[1]

By F. J. ROETHLISBERGER

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Efficiency and Cooperation in Modern Industry

Modern industry presents an interesting contrast. On the one hand tremendous advances have been made in the application of science and technical skill to the economic purposes of business. Scientific controls have been introduced to further the practical purposes of industrial organization. Operations have been logically organized to achieve more efficient ends. Much of this advance has gone on in the name of efficiency, and to this development engineering has contributed a great deal.

On the other hand, nothing comparable to this advance has gone on in the area of human relations. Our capacity to work together has not improved with our advance in material efficiency. Matters of morale and cooperation in our modern factories show no great improvement from what they were 50 or 100 years ago. Whatever slight advance there may have been is completely overshadowed by the new and powerful technology of modern industry. Our social skills have not advanced step by step with our technical skills.

This striking contrast between technical efficiency on one hand and matters of human cooperation on the other presents the number one problem of our present industrial civilization. It is obvious that we know a great deal more about machines than people. The technical skills of modern technology can be made explicit and communicated. To them science has been applied. Our social skills, on the other hand, are largely personal, empirical, and intuitive. They are so rooted in tradition that they cannot be made explicit. To them science has been little applied.

It is my opinion that there is no way of dealing with this problem other than the way that all the sciences have taken. We need to know more about what happens to people at work, and particularly we need to have more first hand knowledge. In the field of human relations, as in other areas, there is no substitute for first hand knowledge. We need a knowledge of acquaintance with the facts of cooperative behavior and simple skills of dealing with them.

Once this road is taken—and we have not traveled on it very far—I have become more convinced of the following observations. I find little justification for the prevailing assumption that so long as we turn out goods efficiently of good quality and of low cost, matters of cooperation can be left to chance. I find little evidence for the popular beliefs that cooperation is a matter of logical and technical contrivance or a matter of verbal exhortation—something that can be willed into being by verbal persuasion or efforts of personality. I find that there are just as brute and stubborn facts that determine matters of cooperation as there are brute and stubborn facts that determine matters of technical efficiency, and I find that there are just as specific methods, skills, and a point of view which can be employed to ensure

[1] Presented at the annual meeting of the Ohio Section at Ohio University, Athens, Ohio, April 9, 1949.

cooperation as there are equivalent tools for ensuring technical efficiency. To the relevant methods, skills, and point of view of dealing with the simple facts of cooperative behavior, I give the name of "human relations."

I want to consider two questions: (1) What do we know about the determinants of cooperative behavior and (2) how can we apply what we know? Let me begin by looking at the determinants of cooperative behavior first from the point of view of the individual.

Cooperative Behavior from the Point of View of the Individual

There is a widely held notion that people at work are primarily motivated by economic interest and that in their pursuit of economic gain they are essentially logical. According to this version the major inducement to cooperate is the factor of monetary return. Wherever and whenever this assumption has been seriously investigated in the light of facts, its universal validity has been seriously questioned. Investigator after investigator has agreed on this point. Far from being the prime and sole mover of human activity in business, economic interest has run far behind in the list of incentives that make men willing to work.

Although it would be incorrect to say that this oversimplified version of the economic motivation of people at work has been completely discarded, nevertheless in the past 25 years another picture has grown up with which it at least has to compete. According to this view, people at work are not too different from people in many other walks of life. Whether they work at the top or middle or bottom of an organization, they are not entirely creatures of logic; they too have feelings. For example, they like to be praised rather than blamed. They do not like to have to admit their mistakes—at least not publicly. They like to feel important and to have their work recognized as important. They like to feel secure and independent in their relations with their superiors. Moreover, also, they like to express their feelings. They like to be listened to and have their feelings and points of view taken into account. They like to be consulted about and participate in the changes which will personally affect them. In short, they too like to belong and be an integral part of some group.

According to this version man at work is a social creature as well as an "economic man." He has personal and social as well as economic needs. Work provides him with a way of life as well as a means of livelihood. To understand his satisfactions and dissatisfactions at work, one has to understand the social as well as the physical and economic setting in which his work takes place. One has to understand the kinds of relationships he has developed or can develop with his bosses, his subordinates, his co-workers, as well as with other people and groups in the organization. One has to understand the opportunity for social development and for the satisfaction of needs these relationships afford. Within these relationships can his basic social and emotional needs be satisfied?

From this point of view, therefore, cooperation depends upon two factors: (1) the social needs of people and (2) the opportunity which the environments offer for the fulfillment of these needs. This point of view, it should be noted, forces us to look as carefully at the social as at the material environment of the worker. It forces us to look at his social as well as his economic needs.

Two Basic Needs of People at Work

Any attempt to clarify the needs of people is admittedly an arbitrary one for the sake of convenience. I merely want to point out two very basic needs which often are in conflict.[2] On the one hand we want to be liked and approved of. We want to be able to do those things

[2] See Nathaniel Cantor, "The Dynamics of Learning" (Buffalo, Foster & Stewart Publishing Corporation, 1946).

which give us a sense of belonging. This need to belong and to be an accepted member of a group is very important and necessary for all of us. On the other hand, we also all want to be independent and express our own differences. We want to do things in our own way, to express our own unique feelings, to be ourselves in order to maintain our own feelings of self-esteem.

These two needs—for dependence on one hand and for independence on the other—are often in conflict. Too often we want our cake and eat it too. We want the approval of others and the sense of security which such approval gives us. At the same time we want to tell people off—we want to tell them "to go to hell" and yet fear the loss of support which such behavior might engender. It is obvious that if these needs are out of balance, the feelings they manifest do not make for cooperation. In modern industry, I find this conflict fairly acute. Too many people are in the position of wanting to tell their bosses to go to hell and yet are afraid to do so. (In this connection it should be noted that the union often offers a socially accepted form of expressing some of these feelings.)

Now, although many psychologists would have us believe that the resolution of this conflict can only be achieved by a better understanding of ourselves, I should like to turn to another aspect of cooperation before we reach this conclusion. Let us look at cooperation not only from the point of view of the individual, but also from the point of view of the group.

Cooperative Behavior from the Point of View of the Group

People at work are related to each other in many different ways, many of which are not represented in the organization chart or manual. Not only are they organized in terms of the technical requirements of the job, but also they are organized in terms of sentiments, social customs, codes of behavior, status, friendships, and cliques. In their daily associations together, people at work tend to develop routine patterns of relationships and social codes of behavior. They come to accept these patterns of behavior as obvious and to react as they dictate. Within this system of relationships each task performed has a rank in an established prestige scale. Each work group becomes a carrier of social value. Each job has its own social values and its rank in the social scale. Each worker has a social as well as a physical place in the organization.

In any coordinated human activity, people belong to small work groups. It is in these small work groups that their meaningful associations and activities take place. It is only through their activities and associations in these small work groups that they become related to the larger total enterprise. In business each small work group has its technical and economic purpose in terms of which its members are formally related. But also, each of these groups has its own informal codes of behavior, its own norms of conduct, and its common ways of thinking. These common codes and beliefs not only provide important functions for the individual; they also provide an effective basis for cooperation. They have the effect of making each individual feel an integral part of the group. They bind people into routine collaborative activity. They give people a social place and feeling of belonging. They provide the framework for the fulfillment of human satisfaction. They give people a feeling of self-respect, of independent choice, of not just being cogs in a machine. Far from being a hindrance to greater effectiveness, informal organization provides the setting which makes men willing to cooperate. It is in this setting that man's needs for dependence and independence can be brought into working balance.

It should be noted that these manifestations of informal organization are spontaneous phenomena which arise wherever coordinated human activities exist. They

cannot be prevented because they are the product of man's inherent desire to be a part of and belong to a group. They are not logical in character because they are concerned with values, ways of life, and ends in themselves. They are those aspects of social life which people try to protect and preserve and hence they cannot be changed quickly.

The importance to people at work of these informal groups can best be seen in relation to the introduction of change, when new methods or standards are initiated, newcomers are added, someone is transferred, upgraded or promoted. Any supervisor knows the time it takes for such groups to accommodate to such changes. Any change which can be regarded as an interference to their customary routines and personal interrelations is viewed with alarm and suspicion. Although these informal groups appear at all levels in the organization, the character of these groups in modern industry at the bottom of the organization is peculiarly significant, because, at this level more than at any other, the ways of life of these groups are constantly in jeopardy from technological changes, new methods, raised standards, and manipulation of one kind or another. As a result, these groups in industry take on a highly defensive and protective character. Their major function becomes unfortunately the resistance to change and innovation, and the codes and practices develop at variance with the economic purpose of the enterprise. These defensive and protective characteristics of many informal groups at the work level exist full blown in many factories, even before any formal union appears.

From the point of view of group behavior, then, cooperation, far from being a matter of logical and technical contrivance, is much more a product of relationships involving feeling and sentiment. Far from being something which can be willed into being by legislation, verbal persuasion, and efforts of personality, cooperation can only take place within the framework of established and accepted social structures. It is not something which springs up overnight, something which is here today and gone tomorrow, something which can be put into a group from the outside. Cooperation is dependent upon routine relationships developed and practiced over a long period of time. It is dependent upon codes of behavior by means of which people work together in a group without any conscious choice as to whether they will or will not cooperate. It is dependent upon a certain stability in the ways of life of groups. Only under these stable social structures can peoples' needs for achievement, security, independence, participation, status, and growth be realized.*

Cooperative Behavior from the Point of View of Modern Technology

So far I have looked at cooperation from the point of view of the individual and his feelings and needs. I have also looked at cooperation from the point of view of the group and its social codes, routines, and sentiments. In each case I have wanted to show that cooperative behavior is a product of feeling and relationship. In essence, it is not something logical in character.

Let us now look at cooperation from the point of view of modern technology. From this point of view industry is not primarily organized to ensure cooperation. It is primarily directed to the production of goods of good quality at low cost. But more than this, modern industry is no longer turning out customary products in customary ways for customary customers. It is committed to turning out new and different products in more efficient ways and at lower costs for more quality-and-price-conscious consumers. To this end science and technology have committted themselves, with the result that the environment of the modern factory is quite different from the old know-how shop. In the modern standard shop there are a large number of people whose sole purpose is to originate better ways,

more efficient and less costly ways of doing things, as well as to devise standards and controls to see to it that these goals are secured. The far-reaching repercussions of their activities for the social organization of industrial concerns is serious. Introduced without awareness of their effects upon the informal social organization, these activities can easily (1) dislocate people, (2) interfere with their established ways, (3) break up work groups, (4) prevent the development and practice of routine relationships, and (5) produce feelings of anxiety, insecurity, and frustration—what is often referred to as the feeling of being "pushed around." In short, the logical organization of efficient operation can operate against the social organization of teamwork. Many of the changes modern technology originates can collide head on with the social organization of the company and its attempt to maintain internal stability—a necessary precondition, as we have seen for cooperative behavior. With the very best of intentions, modern technology can unwittingly foster the segmentation of the social structure of industry into groups with radically different points of view. It can unwittingly assist in the development of rigidities of relationship between segments of the structure that make cooperation difficult, if not in some cases impossible. The patterns of behavior produced by modern technology do not in and by themselves make for cooperation.

Cooperative Behavior from the Point of View of the Executive

So far we have been looking at cooperation from the point of view of the people whose cooperation is being sought. Let us look briefly at cooperation from the point of view of those who are trying to secure it. It is one of the functions of the executive to secure the understanding of people to the purposes of the organization. How does he do this? According to one version the executive gets things done through the authority of his position and the clarity of his communication. How these assumptions came about, I do not know because so far I have found little evidence to support them.

Most of us know people who, with all the formal authority in the world and with an unusual capacity to express themselves logically, have great difficulty in getting cooperation. Likewise, many of my more inarticulate friends in positions of little formal authority seem to have no difficulty in securing the understanding of people. It has frequently been noted how some people lose what little authority they have by issuing orders they know cannot or will not be obeyed. Authority does not reside in the superior individual; it resides in the kind of relationship the superior has developed with his subordinates. Without the cooperative attitudes of subordinates, the voice of authority can speak, but the big booming voices it makes do not register upon people.

An extraordinary blindness to this point about securing the understanding of people is well manifested by what I shall refer to as the "tell-'em, sell-'em, explain-it-to-'em" school of thought. Whenever situations arise where people are reluctant to follow or accept cheerfully certain management orders, policies, changes, goals, aims, or what not, this school of thought immediately assumes that this state of affairs exists only because the people involved do not logically understand the need for the order, change, new objective, or what not. This school of thought assumes that a clear order is automatically always obeyed; that the logical and lucid exposition of an aim is sufficient for people to accept it; that any change is cheerfully accepted when the need for it is logically understood. As a result, all problems relating to the securing of people's understanding are resolved by the "tell-'em, sell-'em, explain-it-to-'em" technique. People are told most solemnly how their rates of pay have been determined, how and why this is the best method to do

their work, why this is the best company to work for, etc. Whenever this method fails and people still don't understand all that is told them, this school of thought, being unable to question its assumption about matters of human understanding, is forced into either one of two conclusions: (1) "These clucks are just too damn dumb to understand," or (2) they still have not been clear enough. In this latter case they continue feverishly to draw more charts and diagrams, prepare more manuals and bulletins, and hire more experts in communication to explain policy in words of one syllable, so that this time even a moron will really understand management's good intentions and purposes.

The Case of Mary

In this connection I can think of a young married woman, whom I shall call Mary, who was hired for temporary work by an office manager for a temporary job and because it was against the policy of the company to hire married women for permanent employment. When Mary was hired she was told about this policy, and six months later when she was told that her services were no longer required, she was again reminded about the policy of the company against the permanent employment of married women. Because her work had been of good quality, the office manager even gave her two weeks' advance notice and two weeks' advance pay. At this point, Mary, instead of being appreciative, began to accuse the office manager and the company of giving her a "raw deal." She told her story to many people; how she had been allowed to stay on for six months, how during this period another person had been hired, and why therefore she shouldn't be the one to go, etc. The assistant manager, the office manager, with the credit manager all reasoned with Mary unsuccessfully. They told her over and over again about the company policy regarding married women. But she would have none of it. Before she left she succeeded in raising such a rumpus that she finally got the attention of the president of the company. The poor office manager was bewildered and hurt at Mary's unreasonable response.

Although we can all sympathize with the well-intentioned office manager, the interesting point in this situation is that what Mary was told and what Mary heard were two quite different things. People are more likely to hear things in terms of their feelings and personal situation. Mary was the sole support of an unemployed husband and a child—a fact which the office manager, when hiring Mary, did not find out. Temporary work, therefore, was no solution of Mary's personal problem. If the office manager had talked to her about that before hiring her, or at least during the six months' period of her employment, she might have heard what he said. But he was trying to get her to understand the policy of the company. In this process he was crystal clear, but in terms of Mary's situation and her feelings of permanent status after six months' employment, it was certainly the last thing Mary was capable of hearing.

This instance may be trivial, but it illustrates simply the futility of trying to explain things to people merely in terms of the speaker's point of view and without taking into account the point of view of the person to whom the explanation is being given. This approach assumes that people emotionally accept what they logically understand. It refuses to accept the fact that people are motivated more by matters of feeling and sentiment than matters of fact and logic. No amount of logical explanation from management's point of view will be emotionally accepted by people if it fails to take into account their personal situations and feelings. It only provokes argument and irritation—a feeling of being misunderstood.

Effective communication between superior and subordinate generally starts with listening on the part of the superior

and in trying to understand what the subordinate means within his own frame of reference before the superior starts talking. And when the superior does talk, he is more likely to be understood if he addresses himself to the needs and feelings of the subordinate as well as the purposes of the organization.

What Skills Does the Executive Need?

If my analysis is correct, modern industry needs more executives trained in more explicit skills of securing understanding and cooperation. The complex social system the executive has to administer requires more explicit human relations skills. If the intuitive and traditional ways of handling our human relations no longer work, what are these new skills the executive needs? Can we specify them more clearly?

Inasmuch as these skills are closely related to the phenomena I have been describing, I have already indicated my answer in part. From what I have already said about the nature of cooperative behavior, it should be clear that the practitioner of these skills has to be oriented in the following manner:

1. He has to address himself to what is important to people from their point of view as well as from his own and to make sure he does not confuse the two.
2. He has to address himself to people's feelings, attitudes, and personal background as well as to their more logical motives and purposes.
3. He has to look at the relationships people have with one another from the needs of individuals these relationships satisfy, as well as from the more logical purposes that are secured through them.
4. He has to think in terms of organic rather than mechanical analogies.
5. He has to be clinically, rather than merely logically, oriented.
6. He has to have a capacity to size up total situations and responses to them.
7. But more than practicing these skills of diagnosis, he also has to practice skills of communication and action. He has to develop a skill of helping people to feel secure, to learn from their own experience, to reach their own decisions, and to become more mature and independent.

I hope that these very brief statements will help to convey in a very general way the nature of these human relations skills. But I would be very remiss indeed if I did not point out to you that to specify these skills, though difficult, is not nearly so difficult as to practice them.

Can These Skills be Learned and Practiced?

The learning and practice of these skills are extremely difficult. About this there can be little question. The difficulty does not seem to arise because these skills are difficult to understand intellectually. Nor is it due solely to the fact that these skills, like any skill, have to be practiced in order to be learned, and that they cannot be learned merely from a text book. These difficulties are present, of course, but the blockage goes deeper than this. During the many years I have tried to practice and teach these skills, I have come to believe that the major difficulty arises from the uncomfortable feelings which the practice of these skills sets up in the practitioner.

As I have said, for most of us these skills are rooted in the personal, the intuitive, the customary, and the traditional. To make them explicit makes many of us uncomfortable and uneasy. It forces us to become more conscious of ourselves—our own attitudes and feelings—and how they affect what we do and say. It makes us conscious of our own unconscious manipulations. But more than this, the practice of this skill requires an emotional acceptance on the part of the practitioner of two propositions which often go against our traditional attitudes.

1. It requires a willingness to accept the importance and inevitability of nonlogical behavior.
2. It requires a willingness to see and appreciate points of view different from our own.

For most of us these propositions are difficult to accept emotionally. It is not difficult for us to understand that people are motivated more by matters of feeling and sentiment than by matters of fact and logic. It is not difficult to see that people are members of groups and act in accordance with the sentiments of these groups (which is all that I mean by non-logical behavior). But to practice this understanding is another matter.

It is obvious, for example, that we all do not perceive the world the same way. What is important to one person or group is not important to another. Matters that are of importance to management are not of the same importance to employees. Older service employees do not share the same values as younger service employees. What is important to professors may not have the same weight with students. And so on and so on. I shall not belabor this commonplace observation. All of us have had sufficient experience to realize that we do not perceive the reality quite in the same way as our parents, our teachers, our bosses, our wives, or our children.

It is also obvious that people respond to the reality as they perceive it to be and not as it actually is. Two workers may perceive their common boss in quite different ways. If worker A perceives his boss as a domineering individual, he will respond in terms of that reality; if worker B perceives this boss as a rather pathetic, insecure person, he will respond to that perception. It is very likely that neither perception resembles the perception that the boss has of himself nor the perception the boss's boss has of him.

But what makes the situation still worse is that although many people can understand these matters intellectually, they cannot accept them emotionally so that they can apply their understanding with any skill. The emotional acceptance of individual differences—our own as well as that of others—is a painful process of maturation.

How Can the Skills be Learned and Taught?

Because of the emotional difficulties in learning these skills, I have come to have a few simple ideas about a method of learning and teaching them. Some of the elements of this method, which I shall call the case method, I should like to call to your attention.

In this method of instruction we start with a "case," i.e., a simple description of what actual people said, did, and felt in a concrete situation. The student is asked what he would do in such a situation were he in a position of responsibility in it. Moreover, he is asked not only what he would do, but how he would do it—what needs to be done and how to do it. By stressing this latter half, the student is made to realize the difference, for example, between "being tactful" in general and what the particular tactful remark in this particular situation would be.

In the human relations area I cannot stress enough the importance of this distinction. Too often our solutions are merely verbal because we do not address ourselves sufficiently to how we are to accomplish what needs to be done in a concrete situation with particular people who have particular feelings, needs, and relationships. It is always easier to deal with the "average person" than a particular person in a particular situation.

In the discussion of this case, therefore, the student is forced to face up to the attitudes and feelings of different people in the case. He comes to see how the same situation may look different to different people and groups. He comes to realize that he has to take into account these feelings and attitudes as one of the important determinants of the situation

with which he has to deal. Emotionally he comes to accept the fact that these elements are just as brute and stubborn data as other aspects of the situation.

In the discussion of the case the student is also encouraged to express freely his own feelings and attitudes about the people and problems being discussed. Gradually in this way we hope that he comes to recognize his own feelings and attitudes and the important part they play in what he says and does when he tries to deal with a concrete situation. It should be noted that in this process the instructor does not try to change or evaluate the feelings the student expresses. He tries to get the student to recognize his attitudes; it is up to the student to change them if he wants to.

As you can see, this method also requires skills of the instructor. But the skills he practices—it should be noted—are of a piece with the skills he is trying to communicate. The student therefore learns by example. It is no use for the instructor to tell his students about the importance of feelings and sentiments in the behavior of people if in the classroom he ignores the feelings and sentiments of his own students. Somehow the communication does not quite register.

It should be noted this method is quite different from the "tell-'em, sell-'em, explain-it-to-'em" approach. It is based upon quite a different set of assumptions. It does not assume that knowledge is something handed down on authority and that the acquisition of such knowledge is educative in itself. Learning is not based upon the student's ability to hand back abstractions. Learning is not based upon the student's ability to answer questions which the instructor asks. To the contrary, the case method assumes that the learning process is different for different people. It assumes that learning cannot take place apart from the experiences, attitudes, and feelings of the learner. In the case method, therefore, the student is allowed to raise and answer his own questions—not the instructor's.[3]

The case method stresses the importance and subjectivity of personal experiences. Granted that people learn from their experience, it is a fact that people may learn the "wrong" as well as the "right" lessons from experience. People often generalize from too limited experience. Because of certain attitudes they may misinterpret their experience. They may not see the significance of their experience. Before they can learn some things, therefore, they have to unlearn "many things that ain't so." The case method, therefore, assumes that people have to be helped to learn from their own experience. This assistance is the instructor's chief role.

The case method further assumes that learning must start with "concretions" (not "abstractions"), with what we may call action-oriented situations at the "how-to-do" level. Not until the student obtains some intuitive familiarity with these "concretions" and confidence in dealing with them, can he begin the process of formulating adequate generalizations from experience.

It is by this approach that I feel we can in a small way begin to face up to some of the very difficult problems underlying the learning of these human relations skills.

[3] See Earl C. Kelley, "Education for What is Real" (New York, Harper & Brothers, Publishers, 1947).

From the *Bulletin* of the Machine Design Committee of the A.S.E.E. comes the philosophical observation:

"It ain't what we know that causes trouble; it's what we know that ain't so."

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NOMINATION BLANK

"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

In order to make the election of officers of the Society as democratic as possible, members are urged to fill out the nomination form and return before April 1, 1950 to the Secretary, A. B. Bronwell, Northwestern University, Evanston, Illinois.

I nominate the following members of the Society for officers:

For President ....

....

For Vice-President ....
(2 years)

....

For Treasurer ....

....

Signed ....

Title ....

Institution ....

Date ....

Scientific Research, Future Naval Power, and National Security[1]

By THOMAS J. KILLIAN

Science Director, Research Divisions, Office of Naval Research

The imposing title of my talk is not my creation nor that of anyone in the Navy Department. It is part of an act of Congress which was signed by the President nearly three years ago. This was an act: "To establish an Office of Naval Research in the Department of the Navy; to plan, foster and encourage scientific research in recognition of its paramount importance as related to the maintenance of naval power and the preservation of national security." Thus does Public Law 588 direct the Navy to prosecute a vigorous broad research program adequate to meet the future needs of naval power and national security. This is a broad assignment since the Navy is the largest and most complicated technical organization in the world. It is the responsibility of the Office of Naval Research to ensure the scientifically strong Navy essential to the future of our naval power and national security.

To discharge a responsibility of this magnitude requires that the Office of Naval Research do much more than conduct a research program. All frontiers of knowledge in the scientific areas of vital interest to the Navy must be intensively pushed forward. Applicable discoveries arising from research must be quickly made available to not only the developmental agencies of all the Armed Forces, but to industry. A continuing survey of our scientific strength and vulnerability must be made. Our scientific research readiness will without doubt be as important in a future conflict as our immediate operational readiness.

Research Programs

The principal operations of the Office of Naval Research can roughly be divided into two classes—the basic and applied research programs underway in the laboratories operated by the Office of Naval Research and the fundamental research programs which the Office of Naval Research sponsors in the colleges and universities of the country. This latter program is the one most familiar to you and the one to which I will devote most of my time. First a brief word about the ONR operated laboratories.

The Naval Research Laboratory in Anacostia, D. C., is the largest unspecialized research activity in the military establishment. Total employment is approximately 3000 civilian personnel and 30 naval officers. Of the 3000 civilian personnel, approximately 1000 are professional, that is to say, scientists or engineers. This laboratory is essentially a civilian research establishment under Navy management and control. Approximately 20% of the laboratory's effort is devoted to basic research, with the remainder in applied research, development, evaluation and testing. This is in accord with ONR's principle that a certain amount of basic research is essential in all activities engaged in applied research and development work. It is a necessity if the vitality and creative thinking of the scientists employed there

[1] Presented before the ECRC at the Annual Meeting of the ASEE, Troy, N. Y., June 20, 1949.

are to be preserved. Dr. Bush has pointed out that unless particular care is taken to preserve basic work, it will be driven out by the applied.

The activities of the Naval Research Laboratory touch practically every field of physical sciences. The technical activities are divided into the divisions of chemistry, electricity, optics, metallurgy, nucleonics, sound, mechanics and three in radio. The latter exist because of the present concentration of the Laboratory in electronic fields.

The second large laboratory under the direct control of the Office of Naval Research is the Special Devices Center at Sands Point, Port Washington, Long Island. The research and development responsibilities of this center lie in the field of training devices and aids, technical evaluators, and human engineering. The fundamental objectives of the center are to train men more efficiently and to assist in the design of equipment so that it can be more readily operated. It is apparent that all naval armament and all military machinery in general should be designed with the capabilities and the limitations of the human being in mind so that the requirements for extremely complex training, which is expensive in terms of effort, of manpower and most of all of time, may be minimized.

The material bureaus of the Navy are responsible for the design, procurement, installation and maintenance of all ship and shore equipment. Each has under its control several laboratories and test facilities to assist in this difficult task. The Bureau of Ships, for instance, has six well-equipped laboratories with excellent staffs—The Naval Electronics Laboratory in San Diego, California; The David Taylor Model Basin in Caderock, Md., The Engineering Experiment Station in Annapolis; The Material Laboratory in the New York Naval Shipyard; The Underwater Sound Laboratory in New London, Conn.; and the Boiler and Turbine Laboratory in Philadelphia. The other Bureaus similarly have laboratories to assure that the Navy not only has the best equipment that science and industry can supply, but that the highest levels of performance are attained through proper installation and maintenance.

The third large activity of the Office of Naval Research is that of the Research Divisions located in the Navy Department in Washington. These divisions plan, guide and sponsor a huge university research program. The story of this program is exciting. It is the greatest peace time cooperative undertaking in history between the academic world and government. It is the story of an experiment of great significance to science and education. This comprehensive program contains approximately 1200 projects in about 200 institutions at approximately a $20,000,000 a year level. Nearly 3000 scientists and 2500 graduate students are actively engaged in basic research projects of great interest to the Navy. These projects, as you know, were not assigned by the Navy. The original proposals were initiated by the investigators and the contracts were made with their universities. In many cases, the financial contribution of the university equals or exceeds that of the Navy.

Post-war Developments

First, I would like to review some of the thoughts which guided the initiation of the program, then discuss briefly its present status. Finally, I will attempt to look into the future and in particular consider the relationships of this program with the proposed National Science Foundation.

In 1946, we were guided by four facts of great importance. The security and prosperity of this country depend upon its scientific strength. This scientific strength is sustained by the unpredictable but inevitable important results of basic research. Second, basic research is essentially a long-term, peace-time activity. It cannot be effectively conducted in a war-time crash development atmosphere. Third, during the past war, our store of

basic knowledge was exploited to the point of diminishing returns. We scraped the bottom of the barrel. Finally, we do not have basic knowledge essential to develop weapons and counter-weapons we urgently need now.

Conditions existing at the end of the war influenced the university program. The shortage of scientific and technical personnel was acute.

Another immediate problem was the disposition of the research facilities and centers of NDRC and OSRD. The transition to peace time involved conserving these facilities and equipment for the scientific advancement of the country. Europe's scientific activities had been almost completely dislocated. This was especially significant in fields where the principal creative work had been traditionaly centered on the continent. Thus, it was felt necessary to initiate work in fields which had received little or no attention in this country prior to the war. An example of this is the science of low temperatures, cryogenics.

Finally, we attempted to use the vast experience gained during the war in various techniques of accelerating investigations. These include group attacks of scientists of different traditions and backgrounds on one problem, new methods of attack on old problems, and the possibilities of new approaches opening fresh fields of research. Experience has repeatedly shown that in time of stress, scientists can bring their talents to bear in many fields outside of their specialities. Many of the great advances in microwave radar at the Radiation Laboratory at MIT were made by nuclear physicists. On the West Coast, great improvements in rockets and propulsion were the result of the joint efforts of astronomers, nuclear physicists and aerodynamicists.

Units in Research Division

Since the technical strength of the Navy is dependent upon the Nation's scientific well being, research was supported on the basis of the broad scientific needs of the nation. In addition to providing financial support, arrangements were made to use naval facilities and personnel. Naval ships, submarines, aircraft and rockets were used to carry scientists and instruments to regions where significant data could be obtained. The breadth and scope of the program may be realized through a brief mention of the various units of the Research Divisions. The Division of Earth Sciences consists of branches in Ecology, Geography and Geophysics. In this division, broad programs in oceanography, meteorology and earth physics are guided. The country's northernmost research laboratory, the Naval Arctic Research Laboratory at Point Barrow, Alaska, only a thousand miles south of the North Pole, is controlled by this division. The Physical Sciences Division is made up of branches in Physics, Nuclear Physics, Materials, Chemistry, Electronics, and Power. Close relationships between the branches of this division and others have facilitated cross-fertilization in various scientific fields. An obvious case is the use of radioactive elements in tracer techniques. The Materials Branch which uses the results of surface and solid state physics and chemistry in its daily work automatically stimulates this cross-fertilization. In the Mathematics Division, there are branches in Mathematics, Computers, Logistics, and Mechanics. Before World War II, applied mathematics was not fashionable in this country. The activities of the Mathematics Division has done much to raise the scientific level of this country in mathematical statistics, numerical analysis and computing devices. The branches of Physiology, Biochemistry, Microbiology, Biophysics, and Dental constitute the Biological Sciences Division. Under the Human Resources Division are the Human Relations, Psychophysiology, and Manpower Branches. Under these two Bio-Science Divisions, outstanding research facilities and teams have been established. The warfare research division is that of Naval

Sciences. Staffed by officers of combat experience and civilian technical personnel, it consists of four branches, Air, Armament, Amphibious, and Undersea Warfare. It studies, surveys and evaluates the implications of scientific and technical advances on naval warfare.

University Program

The university program is by no means entirely Navy sponsored. We have many joint projects with the Army and with the Air Force. In some cases, the contracts are Army contracts with ONR transferring funds to the Army, and in other cases, the reverse is true. For example, one of our strongest research centers is supported equally by the Navy, Army and Air Forces. This is the type of unification and positive coordination which really produces effective results. A very large fraction of the ONR program in nuclear physics and the applications of nucleonics and atomic energy, to biology and medicine is planned, supported and administered jointly with the Atomic Energy Commission. In this way the coordination of effort in fields of joint interest is automatic.

One of our problems is how to maintain the present vigor and strength of the university program. We feel that one essential is a bilateral flow of scientific personnel between the universities and the ONR staff and between ONR and the research institutions. A sizeable fraction of our staff in Washington is on leave of absence from universities. Similarly, we have ONR personnel on leave from Washington to universities or spending a fraction of their time in creative research.

One of the questions most frequently asked is that concerning our relations with a National Science Foundation should one be established. This problem has been given a great deal of thought. First, the Navy has always given strong support to the establishment of a National Science Foundation. Second, there is general agreement that the National Military Establishment, and the Navy in particular, should be allowed and encouraged to continue the support of basic research at approximately present rates. There will of course be changes in the program. Obviously certain of our research projects can and will be transferred to the Foundation. Precisely which projects cannot be determined at this time. Each must be considered as an individual case. Any transfer must be accomplished through mutual agreement with the Foundation, ONR, the university and the investigator. There are certain areas of the frontiers of science in which the Navy has a vital interest. It should continue to support basic research in these fields. I may mention a few as examples—hydrography and oceanography; underwater acoustics; electromagnetic propagation; mathematical studies essential for the improvement of fire control for operational analysis of computers and for logistics; human engineering; studies of the normal man in relation to his environment with particular reference to arctic, tropic, and other extreme conditions.

The basic research program has made available to the Navy the advice and counsel of many of the outstanding scientists in the country. It is my feeling that the Navy should continue to have available a complete and balanced group of consultants in the biological and physical sciences.

However, the fundamental philosophy of the Navy is that basic research, having no foreseeable goal, will inevitably from time to time uncover new discoveries of overwhelming benefits not only to the Navy, but to our whole industrial and national economy. This is the reason for the existence of the Office of Naval Research and the recognition of the relation of basic research to applied research and development. It is the reason for the existence of the comprehensive program of basic research which the Navy is supporting in the traditional sources of fundamental knowledge, that is in the universities of this country.

With knowledge of our economic and military strength, a potential aggressor can evaluate our vulnerability to various types of warfare and even project the probable course of a war. This actually occurred during World War II in the case of the French Maginot line. However, no one can estimate the capabilities nor the potentialities of retaliation possessed by a nation of great scientific strength. This scientific strength is insurance against war, not only through its potential threat of reprisals against aggression, but also in its great promise to alleviate and eventually remove the causes of war.

Thus, through scientific research, we can be assured of the strength of our future naval power and the preservation of national security.

Planning Civil Engineering Structures[1]

By JOHN B. WILBUR

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It is a privilege to discuss the planning of Civil Engineering structures with this group, because of my conviction that a consideration of the planning process merits an important place in our Civil Engineering educational programs. We hope that our engineering graduates will occupy useful places in society. We expect that some will become experts who excel in a particular technique or skill. We know that others will become leaders in the sense that they will guide the efforts of other people in coordinated activities. In preparation for these careers, we, as engineering educators, place great emphasis upon the ability of students to think clearly.

But to some of us, training in the ability to think clearly is somewhat synonymous with training in what we often refer to as analytical thinking. Let us then consider what is meant by analysis in thinking. Analysis, in its broadest sense, means taking a thing apart and examining the pieces in a systematic manner. Analysis in thinking consists of breaking a problem down into its parts. This is an essential process in attacking a problem. But in reaching decisions and in deciding what should be done in a given situation, the parts of the problem, after having been carefully studied, must be brought together again. This process of bringing the parts together is in some respects the reverse of analysis. It may be called "synthesis in thinking." It involves the synthesis of many factors, and the making of decisions as to what is best "on the whole," or "taking everything into consideration."

Synthesis in Thinking

Perhaps nowhere in Civil Engineering education do we have a finer opportunity to provide students with some practice in synthesis in thinking than in connection with the planning of Civil Engineering structures. And so I approach this paper with a dual enthusiasm: first, because I believe that the planning of Civil Engineering structures or projects represents Civil Engineering practice at a high professional level, and secondly, because training in such planning offers an ideal environment in which to inculcate in the mind of the student the over-all approach to problems based on synthesis in thinking that is so vital to the making of broad scale decisions and to creative engineering.

My subject this afternoon is the "Planning of Civil Engineering Structures." I hope you will forgive me if I interpret the word "structures" in a very broad sense. For my purpose, a structure means anything built by a Civil Engineer. It refers to a pavement or to a pipe line as well as to a building, or a bridge, or a dam. It refers to an entire project as well as to the separate structures that make up the project. Perhaps

[1] Presented before a joint meeting of Architectural Engineering and Civil Engineering at the Annual Meeting of the ASEE, Troy, N. Y., June, 1949.

my title should have been the "Planning of Civil Engineering Projects," or perhaps it should have been "Planning, from the Viewpoint of the Civil Engineer"—because my attention will be centered on the possibility of using the planning process as a device to aid students to develop the ability to synthesize as well as analyze in approaching the problems they will encounter during their careers.

The planning process, broadly speaking, involves three phases. Each of these three phases has as its objective the answering of one of the following questions: (1) What have we got? (2) What do we want? (3) How do we get it? The first phase—the determination of the various factors that are in existence—brings the *problem* itself clearly into focus. The second phase—the determination of a settled or definite course or principle of procedure or action for the problem at hand—establishes the *policy* that is to govern the solution. The third phase—which is that of setting up the procedure by which the policy may be carried out—leads to the *program* that will translate general ideas into specific plans. Thus the three phases of the planning process can be restated as follows: (1) Crystallizing the problem; (2) Determining the policy; and (3) Preparing the program. These three phases are interrelated and cannot properly be separated, but for the purpose of this discussion our attention will center on the second phase, i.e., the establishment of the policy that is to govern the solution.

Major Considerations

Although it represents an oversimplification, I shall begin my detailed discussion by stating that the determination of policy in the planning of Civil Engineering structures, when considered in its broad sense, includes the synthesis of six major considerations, and that these are the ***social*** (including political), ***legal, functional, economic, technical,*** and ***esthetic*** aspects of the problem.

Social aspects must be considered because the Civil Engineer deals with large projects, often of a public nature, that may have important effects on the lives of many people. These projects afford protection against man-made perils as well as the perils of nature. They affect the conservation of our natural resources. They affect housing and other living conditions. The opportunity to contribute to social improvement, and the sense of satisfaction and accomplishment that goes with this, are among the attractions of the Civil Engineering profession. But with this opportunity goes the responsibility of recognizing the social aspects of a problem, and giving them proper consideration in arriving at engineering decisions.

Legal aspects are almost always encountered. They may be in the form of codes specifying certain requirements that must be met in construction, or they may be zoning laws that regulate by districts the height, bulk, and use of buildings, the use of land, and the density of population. They may affect clearance requirements over navigable streams, or water rights in connection with a dam. In general, the legal aspects of a planning problem establish certain definite restrictions within the limits of which the planner must proceed.

Functional aspects are of utmost importance. Every structure is built to perform a certain function, and regardless of its other qualities, it must serve the purpose for which it is built if it is to prove satisfactory. The Civil Engineer does not primarily build a bridge or a tunnel, but rather a means for traffic movement across a body of water or a valley, or through a mountain. He does not primarily build an industrial building, office building, or apartment house, but rather places where people may work and live, protected from the elements, and in an environment that will permit their working and living to be effective and pleasant. He does not primarily build dams, aqueducts, water treatment plants and distribution systems, but rather he provides homes and

industries with water of sufficient quality and quantity. The bridges, skyscrapers, dams, etc., are but the instruments that are used to accomplish certain functions. It is the functions themselves that are the true objectives.

Economic aspects involve two major phases which are interrelated. The first consists of determining whether or not a project is economically justified. While annual cost can usually be established by methods that are largely rational, annual benefits may be more difficult to evaluate. While the latter may be of a tangible nature, they may be partly or wholly intangible. This is because it is often necessary to correlate economic and social benefits. Economic justification usually involves the second phase of the problem—namely, the search for an economically optimum solution. In dealing with this phase it is well to keep in mind that as a given parameter is varied so that the cost of certain items is reduced, the cost of other items will increase. This compensating tendency tends to prevent sharp changes in total cost as a parameter is varied, and this is particularly true in the region of the optimum. In general the objective should be that of assuring one's self that his solution lies near the optimum, i.e., it lies in what may be called the optimum range, rather than that of seeking truly optimum conditions.

Technical aspects are of first-order importance, but since they are amply covered in most Civil Engineering curricula, they will not be enlarged on here. Suffice to point out that while we may be prone to think of the technical requirements of a structure as being of a rather definite nature, there are actually many factors requiring judgment of a high order in connection with this aspect of planning. This is because technical requirements vary with social and technological changes, because they depend on the vagaries of nature, because they depend on operational uncertainties, and because they involve probability considerations. Nor is the technical performance of a structure as definite as we might wish. This results from uncertainties in properties of materials, in methods of analysis, in methods of fabrication and erection, and in connection with maintenance. The actual factor of safety that should be built into a structure will depend on considerations such as penalty for failure, expected life of structure, degree of certainty involved, etc.

Esthetic aspects include a consideration of fitness to function, materials, and techniques. They involve attention to unity, simplicity, good general lines, harmony with environment, and ornamentation. The engineer in designing a structure has the cards stacked in his favor to produce a beautiful structure, since by the very nature of his work he is seeking a design that is fitted to functions, materials, and techniques. Pleasing effects can therefore be obtained at little or no extra cost. In view of this, it is perhaps not too much to suggest that if beauty of structure is not achieved, it is likely to indicate poor engineering as well as lack of esthetic appreciation.

To recapitulate, the solution sought in a given instance is a complex function of many variables which must be synthesized by the planner by considering questions such as: Does it recognize social welfare and fulfill social needs? Does it satisfy legal requirements? Does it accomplish the function for which it is built? Is it economically justified, and does it represent the best possible expenditure of funds? Will it operate satisfactorily, and does it take advantage of recent advances in technology? Will it satisfy the desires of people, and bring them pleasure?

Examples of Application of Synthesis Methods

Let us now attempt to illustrate how the various aspects of planning may be combined in the search for a solution to a given problem. As a first example we shall consider an office building in a

metropolitan area, where one might proceed somewhat as follows: *Social* considerations would include taking into account the predominant activities of people in various areas of the city, and the trends in the shifting of these activities that could be anticipated, so that the building could be properly located. They would include a consideration of transportation problems such as accessibility to transportation terminals, street congestion, parking areas, etc. They would include a consideration of the factors covered by zoning laws, such as height and bulk of building, even though zoning laws might not exist. *Legal* considerations would include taking into account the building codes and zoning laws. The zoning laws, through height restrictions and set-back regulations, would be likely to exert a fundamental influence on the general shape of the building. *Functional* considerations would control floor layouts, indicating where light courts were necessary, and thus affect the shape of the building. *Economic* considerations would affect practically every step in the planning, and would be likely to determine the height of the building. *Technical* considerations would affect the details of the design and construction and might indeed have far-reaching effects on the shape of the building. For example, the foundation conditions might limit the weight and weight distribution of the structure. *Esthetic* considerations would affect the actual building shape chosen, together with the details of the exterior and interior treatments.

As a second example, we shall consider the planning of a highway bridge across a navigable stream: *Social* considerations would affect the over-all decision as to whether or not the bridge should be built, and the choice as to the general location of the bridge. The effect of the bridge on adjacent land values would also be taken into account. *Legal* considerations would include the decisions of the War Department with respect to underclearance requirements for navigation, together with factors such as land taking, land damage, etc. *Functional* considerations would determine the number and arrangement of traffic lanes as well as the arrangements for the entrance and exit of traffic. The hydraulic demand of the stream might affect underclearance and pier locations. *Economic* considerations might determine span lengths, would be likely to affect the type of superstructure, and would influence the general proportions as well as the details of the structure. *Technical* considerations would control the detailed design of the members and their connections. Through foundation conditions, they might determine span lengths as well as influence the type of both the substructure and superstructure. *Esthetic* considerations would be taken into account in choice of type and general layout of the structure, and would control any decorative efforts.

A Guide to Finding the Optimum Solution

One is now tempted to attempt to generalize by setting up a guide to the orderly approach of synthesizing the many factors involved in planning a Civil Engineering structure or project. While it must be clearly understood that the actual procedure that is desirable in a given case may vary widely from that of any standard approach, one might proceed somewhat as follows:

1. *View the over-all problem,* giving *preliminary* consideration to its social, legal, functional, economic, technical, and esthetic aspects. This preliminary "sizing up of the situation" will prevent one from going entirely astray as the more detailed parts of the problem are considered.

2. *Social considerations* should be an important factor in determining whether or not a project should go ahead, and in formulating, in a broad way, the general manner in which the problem should be solved.

3. *Legal considerations* usually lead to certain restrictions within the limitations of which the planning must proceed.

4. *Consider a number of possible solutions* that may satisfy *functional* requirements and that are within the realm of reason from the *economic* viewpoint.

5. *Make preliminary designs* for the various reasonable solutions, giving full consideration to the *technical* aspects of the problem.

6. On the basis of these preliminary designs, *select the most satisfactory solution,* with the decision guided by *economic, functional* and *esthetic* considerations.

While the above outline suggests an orderly approach that can sometimes be followed to advantage, it should be emphasized that the reduction of the problem to a step by step procedure does not reduce it to one of analysis only. The correct procedure is one that involves synthesis as well as analysis in thinking. The actual process will involve scanning and rescanning the entire project with respect to all of its aspects; this more or less informal process will and must be superimposed on any rational approach.

Further, it is to be emphasized that while general considerations may be likely to reduce the number of solutions that merit further study—this coming about largely through the process of elimination for schemes with more or less obvious defects—*the final choice, in most cases, can only be made on the basis of comparative studies.*

What we are seeking in a given case is, of course, the most satisfactory solution, which, for the sake of brevity, we shall call the optimum solution. It is perhaps axiomatic that for any proposed Civil Engineering project there is one type of solution that is better suited to existing and future conditions than any other type. The optimum solution results from a consideration of *all* the variables in a problem, and will usually represent a compromise between the objectives of the individual variables. Moreover, the relative importance of the individual variables differs with each project. But it is seldom if ever that the broad gage engineer can or will completely ignore any of the basic elements. He must approach his problem from the *over-all point of view.*

Having accepted the concept of the optimum solution, a number of comments are in order. A so-called truly optimum solution usually has little meaning. Even if a theoretical optimum could be computed, such computations are based on assumptions that invalidate strict interpretation. Actually there are too many variables in most planning problems to permit the hope of working out a theoretical optimum. But these observations need not be discouraging. As was pointed out in discussing economic considerations, when one investigates the effect of changing one variable in a problem, he usually finds that the effect on the total is not too pronounced because of compensating factors. Stated another way, most over-all functions are continuous. Optimum points are not unique. The optimum range is of more importance than the theoretical optimum point. The optimum solution constitutes a general objective even though it is never reached. The fact that it cannot be reached should not prevent one from devising the best solution that can spring from his abilities.

And in devising the best over-all solutions of which he is capable, the student in Civil Engineering will be laboring in a climate that stimulates synthesis as well as analysis in thinking. He will gain experience in the integration of many factors in reaching decisions. And perhaps it is not too much to hope that as he gages his thinking to the broad scales of reference that typify the planning process, he will be aided in developing his potential capacities to achieve a sense of balance and to render sound judgments.

We have all heard about the small boy who took the family clock apart to find out what made it tick. I salute him for his intellectual curiosity, but I would like to help him put the clock back together again.

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DISCUSSION BY W. L. HYLAND, PARTNER

Fay, Spofford and Thorndike, Boston, Massachusetts

Dr. Wilbur's characterization of the planning process as one of synthesis rather than one of analysis is a fresh and stimulating approach to the subject of planning. As one who directs the work of a number of engineers, I should like to make some practical comments on Dr. Wilbur's paper. First, I will discuss the part played by the engineer in the planning process; then, the aptitude of engineers for this phase of engineering, and finally I will make a few suggestions as to the training which the young engineer needs to improve his aptitude for planning.

Dr. Wilbur has referred to the three phases of planning, namely, (1) crystallizing the problem, (2) determining the policy, and (3) preparing the program. The first two phases cover what is commonly termed the preliminary planning stage and the third phase is the detailed design. My comments will relate to the preliminary planning stage.

We all know that the preliminary planning of an engineering structure is not the work of the engineer alone, but that it usually represents the work of many individuals and groups. This is particularly true of public projects. Consider for instance, a large municipal sanitary project—the preliminary layout finally adopted for such a project will reflect the views of local officials and groups as well as those of the engineer, and must have the approval of the State Department of Public Health. Consider a federal aid airport project—the preliminary plan must receive the approval of the Civil Aeronautics Administration as well as that of the Local Airport Commission and should be acceptable to groups of local citizens, such as the Chamber of Commerce. If it is a Massachusetts project, approval will be required also of the Massachusetts Aeronautics Commission and the Massachusetts Public Buildings Commission. Consider a project being handled by a private engineer for the Department of the Army. Here the preliminary plans may be reviewed by the Chief of Engineers, the Division Engineer, and the District Engineer having supervision over the work, also by the Using Agency. Projects for private owners usually do not receive the attention of as many different groups as public projects; nevertheless the ideas of many people are presented for consideration in the preliminary planning stage.

Now the engineer has to sift and to coordinate the ideas of these various groups and to satisfy them as to the plans finally adopted. Although the preliminary plan is usually the engineer's responsibility, sometimes laymen play a larger part than the engineer; this is so particularly for projects with preeminent social and economic aspects, these being the categories in which the layman can make his greatest contribution. When there is considerable layman participation, the planning process is time-consuming and a large project may take years. A case in point is the sewerage system for the City of Cranston, Rhode Island, which remained in the planning stage in the writer's office for almost twenty years before authorization was given for the detailed design. During this period the project was rehashed many times before all parties were satisfied.

Obviously, in initiating the plan and in synthesizing the ideas of others incorporated in it, the engineer has an opportunity to render professional service of the highest type.

In terms of cost, the planning stage usually represents from 15 to 25 per cent of the combined cost of planning and designing a project. However, the engineer plans more projects than he designs and, in the aggregate, the individual professional engineer spends about as much time on preliminary work as on final designs. Engineers high in their profession spend more time in administrative and planning functions than in final design. Planning is such an important function of civil engineers who have passed from the sub-professional to the professional stages of their careers that preparatory training in planning appears to be in order, as follows: (*a*) Undergraduate instruction in planning and (*b*) Self-instruction and conditioning by young engineers along lines mentioned later.

Now, we might ask what aptitude does the average engineer display for over-all planning. It is the writer's experience in observing the work of young engineers over a period of many years that they have little conception of the planning process, or of its aspects. Of course, even if they had they would need experience to become effective planners just as they would need experience to become effective designers. But it appears that their training has been such that they are much better adapted to designing than to planning.

In my opinion some of the reasons for this lack of planning aptitude are as follows:

(*a*) They have not been exposed to instruction in planning;

(*b*) They are in a technical rut. Since leaving engineering school their work has been confined to the technical aspects of final design and construction. They have neglected to cultivate civic and cultural interests and have not been conditioned to recognize opportunities to rise to a higher professional level.

A great handicap to the young engineer is his apparent neglect to improve his use of the English language. He appears not to recognize the necessity for excellence in the preparation of written reports and for making data presentable and easily digestible.

I suggest that the students be exposed to the kind of thinking given in Dr. Wilbur's paper. Also that they be encouraged in preparing final theses to attack problems having aspects other than the merely technical. By all means more stress should be laid on courses in English. Furthermore, they should be advised to broaden their scope by attending meetings, not only of professional societies but of civic groups, where they will mingle and work with people other than engineers.

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Discussion by ROBERT B. B. MOORMAN

Professor of Civil Engineering, University of Missouri

Again Professor Wilbur has presented a thought provoking paper. We civil engineers are too prone to think only of the technical aspects in the planning of projects. However, Professor Wilbur has opened the gate to greener pastures upon which we may graze.

I would like to recapitulate the six major considerations presented by Professor Wilbur in the light of my experience in connection with the planning of an expressway for the City of Richmond, Virginia. It should be understood that I am not attempting to give a complete picture of the items under each of the six major considerations, but merely to point out that there are items to take into account under each of the six major con-

siderations. Also, I shall add two or three more subjects to think about.

The *social* aspects, which I consider to be extremely important, enter the picture through the possibility of slum clearance, confinement of the central business district, and making possible the opening of new subdivisions.

The *legal* aspects would include the determination of how far the engineer can go in the condemnation of property and buildings, in the disruption of the business of concerns on the route, and of zoning considerations, i.e., the use of the expressway where possible, to separate the business or industrial zones from the residential zones.

The *functional* aspects are: to provide for uninterrupted flow of traffic through congested districts, and to provide easy access to the central business district from outlying districts.

The *economic* aspects to consider are the most economical layout from a purely technical standpoint, razing of least expensive buildings, savings to user in regard to gasoline, time, wear on car, etc., and enhancement of property values adjacent to expressway.

The *technical* aspects to consider are use of latest technical information in regard to drainage, road surface, lighting, marking, sight distance, structures, etc.

The *esthetic* aspects consist of such things as landscaping and providing graceful grade separation structures.

To these six major considerations I would add the following items. We might possibly consider them as submajor.

Financing aspects might in some cases be classed under the economic heading. What I have in mind is the raising of the necessary capital to finance the project. There may be a private investor or a public investor. The public investor (city, state, or, federal government) would raise the necessary funds by taxation. There would more than likely be a bond issue election. This brings up another consideration.

Selling the idea aspect is a necessary evil. We engineers ordinarily do not think of ourselves as salesmen. Yet every project must be sold in some way or another. The idea of the project must be presented to the interested and influential groups in such manner that they will back it. In this respect we must maintain good public relations; and an excellent method of doing this is to cooperate with the newspapers and get them on our side.

Another aspect which seems important to me is *National Defense*. Along this line I would say we must guard against easy sabotage of any project with which we are concerned.

Returning to the original six major considerations, we may compare them to six steps in the construction of a sentence. (1) The technical aspect is the alphabet whereby we have a means for construction. (2) The esthetic aspect is the word whereby we make pleasing sounds. (3) The legal aspect is the grammar or set of rules whereby we arrange the words. (4) The economic aspect would consist of using only the necessary words to make our point. (5) The functional aspect is the construction of the sentence. (6) The social aspect is the most important of all for it is the meaning of the sentence.

Meeting

A meeting of the Cooperative Engineering Division of the A.S.E.E. will be held at the University of Detroit on January 24 and 25, 1950. For additional information contact D. C. Hunt, University of Detroit, Detroit, Mich., or H. L. Minkler, Illinois Institute of Technology, Chicago, Ill.

Research Policies and Pitfalls[1]

Summary Prepared by JOHN I. MATTILL,
Secretary, Engineering College Research Council

Assistant Director, News Service, Massachusetts Institute of Technology

Policies and pitfalls in the administration of university research (termed by Ralph E. Montonna "a delicate flower which must not be forced") were the subject of eight university research directors at a roundtable of the Engineering College Research Council of the A.S.E.E. in Kansas City, October 28. "Academic research," said Dr. Montonna, Director of the Industrial Research Institute at Syracuse University, "if properly stimulated can become a very beneficial part of university activity."

Since colleges have no desire to let research overshadow educational goals, Charles W. Williams, Coordinator of Research at Case Institute of Technology, pointed out, college administrators must "examine research in a different light than if it were a goal to be pursued in itself." The effect of research on other university activities should be considered, he stressed.

All participants agreed in emphasizing integration of research with educational effort; the character of research should be such that all projects fit in "with the research interests and desires of the faculty," Dr. Montonna said. All administrators reported efforts to encourage their faculty members to participate in research. Where an engineering experiment station is only beginning to function, as at the University of Arkansas, this presents special difficulties, Dean George F. Branigan reported. J. O. Maloney, Executive Director of the University of Kansas Research Foundation, said that some faculty members may hesitate to accept projects under industrial sponsorship because these are regarded as "risk" operations in which a failure to produce results within a specified time limit may endanger professional reputation.

"It has been our policy," declared Clark A. Dunn of Oklahoma A. & M. College,[2] "to encourage research workers to begin with simple problems, out of which almost always come questions of a more important and fundamental nature." At Oklahoma A. & M., as elsewhere, special efforts are made to recognize research work and to publicize it as rapidly as possible, "giving full credit to the research worker for his contribution."

Extra compensation for faculty members participating in sponsored research was reported by some roundtable participants, notably Dean R. C. Ernst, Director of the University of Louisville Institute of Industrial Research. Other speakers reported that research was encouraged only to the extent of reduced teaching loads wherever possible; such a policy is

[1] A summary of the papers and discussion at a roundtable on "Research Policies and Pitfalls: Policies to be Adopted and Pitfalls to be Avoided in Developing a Research Program Serving Teachers, Students, Industry, and the State," presented before the Engineering College Research Council in Kansas City, Missouri, on October 28, 1949. Texts of the brief papers presented at the roundtable are available from the Secretary of the Research Council.

[2] The paper prepared by Dr. Dunn was read by Dean Edward R. Stapley.

designed to keep faculty emphasis on educational goals. Most participants reported permitting students to be employed on research, though some do not pay students working on thesis projects.

J. Hugh Hamilton, Director of the Utah Engineering Experiment Station, University of Utah, stressed the importance of assured continuity in academic research activities. Thus there is hesitation to accept short term industrial and government contracts, especially in small schools where one contract may provide a significant portion of research income.

Proper administration of patents was also cited as important in stimulating research activity. The main function of university-held patents, said Quincy Ayres, Assistant to the President at Iowa State College, is not to make money but to stimulate interest in and protect university research results. No "infallible rule for predicting in advance the income-producing proclivity of any patent" seems to be known, he said.

Library searches, which are necessary to establish the foundation and value of any contemplated research project, are often a difficult and tedious process for faculty and graduate students. Dr. Dunn reported that a member of the Oklahoma A. & M. engineering library staff has been especially selected to help researchers in this task. While most engineering schools have excellent teaching libraries, essential research data may be missing, Dean Branigan said. Funds from sponsored research overhead may be allocated for this purpose; at many educational institutions such funds are used to support studies by faculty members for whom direct industrial contracts are not available.

Such a policy helps to make possible a relatively even distribution of research in all departments, cited by Dr. Williams as one of the administrative goals at Case Institute of Technology. Inter-departmental cooperation was seen as one major benefit to be derived from any comprehensive research project.

At Oklahoma A. & M. College, a Research Apparatus Development Laboratory serves all research workers by "providing a knowledge of the available equipment and methods of designing equipment to meet specific needs." Many research workers, Dr. Dunn declared, "know only what they wish their equipment to accomplish" and so require the services of such a special design group.

The benefits to be derived by faculty members participating in research projects were graphically suggested by Dean Ernst, who reported on the results of A.S.E.E. grants made possible by the General Education Board in the Southeastern Section. In cooperation with the Tennessee Valley Authority, faculty members have undertaken specific research problems and report "practical and realistic training" which eliminates the "inbreeding and narrowness found on some college campuses."

Without exception, research directors participating in the Kansas City roundtable reported faith that their organizations, properly managed, can stimulate faculty and student research and publication and can provide improved facilities and environment for educational activities. Some believed that research, either directly or indirectly, could contribute to increasing staff stipends. All agreed with Dr. Montonna that "sponsored research is a proper university activity if kept within proper bounds. Research should not be set up in a university as a money-making activity."

Bridging the Gap*

By G. P. BOOMSLITER

Professor of Mechanics, West Virginia University

The complaint has often been made that teachers in engineering, indeed I might even say teachers in all academic subjects, tend to confine their teaching to compartments, little related to other subjects in the curriculum, and I presume that most of us will agree that this is true if our particular courses are excepted from the general rule.

Civil and Mechanical engineering instructors assert that Mechanics falls short of transferring to their students what they need. Mechanics deplores the fact that students come to them inadequately prepared in physics and mathematics and they in turn blame the high schools.

Many years ago Miss Sada Harbarger, whom many here remember as an active member of this society, and who was Vice-President in 1936–37 wrote a paper entitled, "The Sag of the Second Year" which was published in the proceedings of the society. She viewed with concern the drop in grades of the engineering class from the freshman to the sophomore year, but noted their recovery in the two succeeding years. She ascribed it to the fact that there was not enough of engineering in the courses of this year to hold the interest and enthusiasm of the student after the novelty and excitement of the first year had worn thin. She felt that the service courses taught during this second year did not adequately bridge the gap.

Interest Arousing Service Courses

Therefore, I am presuming that what I am to talk on is, how the teaching of any service course, while grounding the student in the fundamentals of that subject, can show how it fits into other subjects of the curriculum so as to develop in the student a desire to pursue the subject further in its application to other science, and to prepare the subgrade, as it were, for the foundations in the subjects which follow. To illustrate, the teaching of the moment of inertia of areas and of masses affords excellent examples for drill in integration. In addition, a brief discussion of the origin of these integrals and of their application to mechanics and engineering would stimulate the student to a fuller appreciation of the calculus and make their use later more understandable.

Similarly, physics teaching can point out many applications of fundamental principles to interesting physical phenomena in mechanics, electricity, sound and light that would serve the two purposes of giving interest not only to that subject, but of developing interest and curiosity in the engineering situations where these phenomena are used.

It is not my intention in this talk to condemn, or apologize and explain, but merely to suggest how mechanics, considered as one of the many service courses which we have in engineering, can be so taught as to serve the various departments of the engineering college and also participate fully in turning out a satisfactory product in the engineering graduate.

Once when I was working as an undergraduate for the college carpenter at Michigan State College, I tried to finish a piece with a pocket knife instead of using a wood plane. He caught me at it

* Presented at the Allegheny Section Meeting of the ASEE, University of Pittsburgh, April 22, 1949.

and after a few well-chosen remarks, he said, "You can noddings do unless you have sometings to do mit!"

Now what do we need and what is available to make the teaching of mechanics a satisfactory service to the other departments? What do we have to "do mit"? First, of course, is the raw material—the students. These, generally, have been screened before coming to Junior mechanics and the better the screening, the better the material. I will not dwell on this, except to say that with the same scholastic training, the more mature students with some experience tend to be the best material to work on. Next is the instructor. Let us suppose that he has been selected with care. He is properly trained academically, which means that he has one or more degrees in engineering and is mentally alert, enthusiastic and sympathetic. What else does he need? Well, a year or two of engineering experience is very valuable. Failing this, summers spent in industry are desirable. This is desirable even if he has had some previous engineering experience. It is also desirable that the instructors in the department come from the various branches of engineering: civil, electrical, mechanical, aeronautical, etc., so that the needs of all departments are most effectively met through the combined knowledge of all in the department.

Then there should be a departmental library in which will be found the best text books in the field of mechanics, both those which are currently popular and those which are out-of-date; the first to develop other points of view—the second to show how present methods of presentation have developed. Also of much value will be the text books in the courses for which mechanics is prerequisite, texts in machine design and simple structures, for example. It should also contain current magazines in the various fields of engineering, or the instructor should subscribe to the ones in his field. Many problems which can be adapted to the class room are obtainable from them.

Instructional Aids

Mechanics principles can be made clear and interesting by the use of simple devices. A few helical springs of various lengths, a rubber beam, flexible steel bars and slender rods to demonstrate the action of long columns and beam deflections. A pendulum or two, revolving tables and gyroscopes to demonstrate dynamic principles, etc. We have a cylindrical box in which is mounted a wheel from a model T Ford with a strip of lead in the rim to increase the moment of inertia. It can be rolled along the floor, but to turn it, a tipping motion is necessary and conversely, deliberately trying to turn it results in its tipping over. A few minutes with this boxed wheel gives a student an excellent illustration of gyroscopic action.

How many instructors have longed for a collection of simple machines such as delight the small boy who visits the Franklin Institute in Philadelphia.

Several years ago Professor Roark of Wisconsin gave a paper before the Mechanics section of the society on "Mechanics in Every Day Experience" in which he cites Prof. Osgood as saying, "The world in which we live is the true laboratory of elementary Mechanics." In this world of the student and teacher are the college shops with their machines, engines, motors and hand tools. On the campus or nearby, new buildings are under construction which, besides showing the application of the laws of mechanics in their construction, are of interest because of the tools employed in their building, shovels, trenching machines, hoisting equipment, floor and wall forms for concrete, etc. The great plants in a great city like Pittsburgh, thanks to courteous and accommodating managers, can be of great service to engineering educators.

Also in the world of all of us, we have base balls, golf balls, automobiles, roadway curves, slippery pavements and the dynamic effect of the failure of the coefficient of friction to maintain equi-

librium. By making use of such devices in mechanics, we can serve the various departments in several ways.

In general we can first develop the student's interest in mechanics and, second, show him its important application to his chosen field of engineering. An enthusiastic student needs no prodding and the secret of good teaching is to make him enthusiastic. Few of us have learned this secret, at least as it applies to a group.

For stimulating the civil engineer, simple structures under construction offer many opportunities. Trusses may be analyzed, floor loads checked, safe column loads determined, walls and footings observed. In a similar manner, modern machine motions may be studied and compared with the older ones used in the shops, stress distribution analyzed, governor action observed. These are all connected with mechanical engineering. In aeronautical engineering, illustrations of aeroplanes will generate discussions on how to eliminate weight and still obtain adequate strength. Samples of thick high pressure pipe in service will show the chemical engineer that there is more to a course in strength of materials than just obtaining a passing grade. Torques in motors can be determined for installations about the campus and the many analogies between Mechanics and Electrical theory should be a stimulus to electrical students.

The illustrations just given for Mechanics will serve also as a stimulus and a bridge in teaching in the Materials Testing Laboratory, but here the bridge should be obvious, or if the course is given concurrently with the course in Strength of Materials, the bridges will be built there. This course should familiarize the student with the common types of testing machines, and with methods of testing, increase his facility for reading data from graphs through making his own and give him a nodding acquaintance, at least, with ASTM standard specifications, but that should not be the principal object of such a course. The first aim should be to translate definitions of such terms as Modulus of Elasticity, Proportional Limit, Ultimate Strength, etc., into well grounded concepts. No one can deal effectively with words which he does not understand.

These are some of the devices for bridging the gap between Mechanics and the professional courses. There are gaps between these courses and the prerequisite courses in Mathematics and Physics that must also be bridged. Physics, for instance, is a broad course of which mechanics is one division, electricity another. What is the gap to be bridged here? I have heard instructors in Electrical Engineering express the wish that students come to them grounded thoroughly in the basic principles of electricity with less stress on what they consider the frills not essential to Electrical Engineering. Mechanics instructors also would be happier if a thorough knowledge of elementary principles were transferred to them.

Need for Hybrid Instructors

One of the best methods of achieving the latter result is an exchange of instructors between the two departments who could then bring back to their department the requirements, problems and points of view of the other one. Another is to have both these groups as well as instructors in the various branches of engineering participate in an Engineering Problems course given in the Freshman year. Picked instructors from Mathematics could well be added to this group. Mathematics has many of the same opportunities to excite an interest in mechanics and engineering, as have been already discussed with regard to Mechanics and the Engineering courses. If Mathematics instructors could acquire the practical point of view of Mechanics, and Mechanics instructors an appreciation of the value of rigid analysis, which is found in Mathematics, both would work most effectively in developing enthusiasm for and understanding of the

various fields of engineering that are so essential to effective training.

But acquiring the facts of a course and even a knowledge of where they are applied in engineering is not the main goal in teaching analytical mechanics. More important is drill in methods of analysis, the direct application of the scientific method without which the graduate engineer is gravely handicapped.

All of the terminology and fundamental principles of any course in mechanics can be written on one sheet of foolscap paper and could be memorized in a week. A knowledge of their application to engineering could be obtained in another week. The rest of the semester is used not in showing the student how they are applied, but in training him in the best methods of doing this himself, in developing his analytical ability.

Professional Objectives

In the November number of the JOURNAL OF ENGINEERING EDUCATION, under the title, "Education for Professional Responsibility," Dean Hammond, as editor, reports on an Interprofessional conference held at Buck Hill Falls, Pa., last April. He used the notes taken by Professors Teare and Smith of the Carnegie Institute of Technology.

He reported that there was a remarkable agreement among all professional groups as to the chief objective of professional education. I quote his statement of this objective, . . . "The chief objective of professional education is the development of the power to acquire and use knowledge as contrasted with the mere process of acquiring knowledge which the student has not used or tested for himself. . . . For an engineer, use of subject matter and skills should be primarily in solving problems. . . . The power to get answers and to put them to work in dealing with actual situations can be developed."

He quotes Professor Teare as dividing cases into *instances* from which general principles are deduced, and *problems* which are used to learn how to use the principles which have been clarified by the solution of *instances*.

Now Mechanics is eminently adapted to do both of these things; first, *instances* to fix principles, and second, *problems* to apply them. Design the joists for the new home or the concrete floor for the new porch, or the shaft for a motor installation, or a spring to carry a given load with a desired coefficient. Check the design on equipment used about the campus or in the shops.

The speaker on one occasion had an amusing experience with a class in Strength of Materials. After discussing the theory of helical springs and noting that there were three variables with but two conditions for their solution so that one had to be assumed before the others could be found, he offered a prize of a lollypop to the student who designed the most economical spring; i.e., the lightest one. When the problems came in, he found that half the class had springs which though of various sizes had the same weight; and taxed the resources of the local candy store to furnish enough lollypops to satisfy the successful designers. It was also of interest that some students tried a dozen different combinations in the effort to obtain the most economical spring. Further investigation of the formula showed that for a given set of working stresses, the weight turned out to be a constant.

The case system in law is used effectively to attain the objectives cited by Professor Teare; i.e., first to deduce the underlying principles of law and second to apply them to new situations. The solution of problems is the use of the case system in engineering.

Requisites of the Teacher

Much emphasis has been placed here on how to bridge the gap in instruction in Mechanics. Instructors in other service courses will find similar means to attain these same objectives relative to

other courses for which theirs are prerequisite.

However wideawake an instructor may be, he must have time to think and plan in connection with his work. With the present large enrollments, there is a tendency to make classes too large and the number of teaching hours too many, and this results in the defeat of many good plans for effective teaching. Seeing a young teacher of English going home with a great armful of papers, her superintendent said, "Remember Miss Blank, a rested teacher is worth any number of graded papers."

I have already stated that an enthusiastic student needs no prodding, but it takes an enthusiastic teacher to develop an enthusiastic student, and enthusiasm depends to some extent on physical energy and mental freshness. The teacher must have time for current reading, intercourse with his colleagues, for attending meetings and experimenting with or making gadgets to illustrate current classroom principles. Too many classes of too many students or a burden of detail or clerical work tends to defeat the best laid plans for effective teaching.

The current issue of *Civil Engineering* quotes Dean Finch of Columbia University's School of Engineering as saying that enrollment there must be reduced from a war-time high of 1100 and a present enrollment of 948 to 800 if the school is to make its best contribution to engineering education and American life. He continues by saying that the facilities of the school have been "taxed to the utmost" in response to a national emergency. Instructors so taxed will have little time to plan how to bridge the gap.

Mid-Year Meeting of Engineering Drawing Division

The meeting will be held January 19, 20 and 21, 1950, headquarters at the University of Illinois, Navy Pier, Chicago. Registration will start on Wednesday, January 18. Northwestern Technological Institute and Illinois Institute of Technology will act as co-hosts with the Chicago Undergraduate Division of the University of Illinois in making all arrangements for the conference.

The conference will open Thursday, January 19th with an inspection trip through Carnegie-Illinois Steel Co., leaving Navy Pier by bus at 9:00 A.M. This will be followed by a visit to the Illinois Institute of Technology in the afternoon. A meeting of the Executive Committee of the Drawing Division will be held Thursday evening.

Friday morning at 9:30 the group will leave Navy Pier to visit the Eugene Dietzgen Company and will be guests of the Dietzgen Company for lunch. In the afternoon the group will visit the Northwestern Technological Institute followed by a conference with speakers from schools and industry. The Annual Mid-Year dinner will be held at University of Illinois, Navy Pier at 7:00 P.M.

Saturday morning the second conference will open at the University of Illinois, Navy Pier at 10:00 A.M. Talks by a man from industry and two from the schools will be given. The meetings will be concluded by a luncheon served in the faculty dining room at the University of Illinois, Navy Pier.

Transportation for both of the industrial trips will be furnished by the host schools. This should be a very worthwhile and interesting conference and we urge all members of the Drawing Division and their friends in the A.S.E.E. to attend.

A Note on the Method of Iteration

By JOHN E. BROCK

Washington University, St. Louis, Mo.

The purpose of this brief note is to direct attention to the fact that the so-called method of iteration[1,2] for solving ordinary algebraic or transcendental equations is at its very best, equivalent to the Newton-Raphson method, and even then involves essentially a greater amount of calculation. Thus, there is no reason ever to use or teach the method of iteration.

In the method of iteration we take the equation,

$$f(x) = 0$$

and write it in the form

$$x = g(x).$$

(This may usually be done in more than one way.) Suppose x_0 is an approximation to the desired root. We form successively the approximations,

$$x_1 = g(x_0),$$
$$x_2 = g(x_1), \quad \text{etc.}$$

This sequence converges to the desired root if $|g'(x)| < 1$ in the neighborhood of the desired root.[3] The convergence is most rapid if $g'(x) \cong 0$ in the neighborhood of the root. If we write,

$$\begin{aligned} x &= (1 - \alpha)x + \alpha x \\ &= (1 - \alpha)x + \alpha g(x) = h(x), \end{aligned}$$

by choosing $\alpha = \dfrac{1}{1 - g'(x)}$ we have,

$$h'(x_0) = (1 - \alpha) + \alpha g'(x_0) = 0,$$

so that the iterative method will converge *most rapidly* for the function

$$x = h(x).$$

Then

$$x_1 = h(x_0)$$

is the first improved approximation. Noting that

$$x = g(x) = f(x) + x$$

(in whatever manner $g(x)$ is obtained), we have

$$\begin{aligned} x_1 &= \left[1 - \frac{1}{1-g'(x_0)}\right] x_0 + \frac{g(x_0)}{1-g'(x_0)} \\ &= x_0 - \frac{g(x_0) - x_0}{g'(x_0) - 1} = x_0 - \frac{f(x_0)}{f'(x_0)}, \end{aligned}$$

which is exactly the approximation giver by the Newton-Raphson method. It is clear that the calculations involved in the Newton-Raphson procedure are essentially fewer in number.

Continuing the iterative process without recalculating an improved value of α is equivalent to continuing the Newton-Raphson method without recalculating the improved value of the derivative, for by the iterative method we have,

$$\begin{aligned} x_2 &= h(x_1) \\ &\left[1 - \frac{1}{1-g'(x_0)}\right] x_1 + \frac{g(x_1)}{1-g'(x_0)} \\ &= x_1 - \frac{g(x_1) - x_1}{g'(x_0) - 1} = x_1 - \frac{f(x_1)}{f'(x_0)}, \end{aligned}$$

while calculating an improved value of α, $\alpha = \dfrac{1}{1 - g'(x_1)}$, is equivalent to repeating the Newton-Raphson procedure

[1] J. B. Scarborough, "Numerical Mathematical Analysis", The Johns Hopkins Press, Baltimore, 1930, p. 184.

[2] E. T. Whittaker and G. Robinson, "The Calculus of Observations", Blackie and Son, Ltd., London, 1924, p. 79–84.

[3] Scarborough, *op. cit.*, p. 186.

with a new value of the derivative, *i.e.*,

$$x_2 \quad x_1 - \frac{f(x_1)}{f'(x_1)}$$

The only time the iterative method might conceivably enjoy an advantage is in the case where we write

$$x = g(x)$$

and it *happens* that $g'(x_0)$ is small, *and* the first or second approximation is sufficiently accurate for the purpose at hand, *and* the calculations are very easily performed. In such a case it would not ever be necessary to calculate $g'(x_0)$. However, in the absence of the knowledge that $|g'(x_0)|$ is small one would be foolish simply to go ahead hoping for the best, and to obtain this knowledge involves calculating $g'(x_0)$.

Incidentally, with respect to the Newton-Raphson Method, it may be pointed out that it is frequently of advantage in computing the first correction to retain second order terms, *i.e.*, to use

$$f(x_0) + \delta x f'(x_0) + \tfrac{1}{2}\overline{\delta x}^2 f''(x_0) = 0,$$

rather than simply

$$f(x_0) + \delta x f'(x_0) = 0,$$

in obtaining δx (where $x_1 = x_0 + \delta x$). In the first stage of the process when the number of digits in the approximate root is small, solution of the quadratic may give a sufficiently better value for δx (as compared to the linear approximation, $\delta x = -\dfrac{f(x_0)}{f'(x_0)}$) to warrant the additional labor. This is not generally true in later stages of the process.

In the News

Federal Security Administrator Oscar R. Ewing announced the creation of a new division in the Bureau of States Services, Public Health Service, to be known as the Division of Engineering Resources. At the same time, Mr. Ewing made public the appointment of M. Allen Pond, Assistant Chief Sanitary Engineer of the Public Health Service, as chief of the new division. Surgeon General Leonard A. Scheele said the Division of Engineering Resources will centralize planning and development of current and proposed programs of the Public Health Service in the expanding field of sanitary engineering and environmental health.

"These are some of the things that, I believe, industry expects from the engineer —achievement, orderly thinking, vision, and the ability to apply these great gifts to human, as well as technical, problems. If I could be permitted to make one suggestion to that engineer as he faces a career in American industry, it would be this: don't be content to deliver just what is expected. Give industry more than it expects. You will then be rewarded by being given even more responsibility and more problems, but these are the dynamics of true progress."—Remarks in address of Charles E. Wilson, President of General Electric Company, at 125th Anniversary of Rensselaer Polytechnic Institute, Troy, N. Y., October 14, 1949.

Division Forum

Student-Faculty Evaluation Subcommittee of Division of Educational Methods

This committee was established by the Educational Methods Division in April, 1949. Its purpose is to review the various programs used by students to evaluate the effectiveness of staff members as teachers. The committee will solicit factual information and opinions regarding these programs from the persons who have been associated with them.

It is not the purpose of the committee to promote evaluation systems and it has not begun its work with the premise that they are desirable. It is thought that comprehensive information on the subject would be useful to all schools in deciding (1) whether or not an evaluation program is desirable and (2) what kind of a program would be most desirable. In the preliminary work of the committee there has been discovered strong sentiments both for and against faculty evaluation programs of all kinds. This certainly betrays considerable thought and discussion on the subject.

The committee plans to sponsor a program at the national convention in Seattle next June. This program will encompass the entire field of faculty evaluation. In addition to a report on Student-Faculty Evaluation there will be one on Administrator-Faculty Evaluation. Other phases of the program are currently being developed.

The members of the committee are Harry W. Case, University of California; John W. Cell, North Carolina State College; Edwin H. Gaylord, Ohio University; Pierre Honnell, Washington University; George G. Lamb, Northwestern University; W. B. Shepperd, Pennsylvania State College; and Paul K. Hudson, University of Illinois, Chairman.

P. K. HUDSON, *Chairman of Subcommittee on Student-Faculty Evaluation*
ERIC WALKER, *Chairman of Educational Methods Division*

Organization of the Pan American Unión of Engineering Societies (UPADI) and the First Pan American Engineering Congress

By S. S. STEINBERG

Chairman, United States Delegation

Dean of Engineering, University of Maryland

The preliminary meetings for the organization of the Pan American Union of Engineering Societies (UPADI) was held in Sao Paulo, Brazil, from July 9 to July 14, 1949, immediately following the Sixth Convention of USAI (The Union of South American Engineering Societies) which was held on July 9. That evening, the formal closing of the USAI Convention and the opening of the UPADI meetings took place at the Municipal Theatre in Sao Paulo at which each chief of delegation made an address. The presiding officer was Dr. Clovis Pestana, Minister of Railroads and Public Works, who represented the President of Brazil.

The presiding officer of the meetings for the organization of UPADI was Engineer Alvaro de Souza Lima, President of the Engineering Institute of Sao Paulo. A Committee was appointed from the delegates of each of the countries represented to consider the proposals previously prepared for a Constitution for UPADI.

The formal opening of the First Pan American Engineering Congress took place on the evening of July 15 at the Municipal Theatre in Rio de Janeiro at which several chiefs of delegations were asked to deliver addresses. The scheduled sessions of the Congress and its Commissions commenced the next day. At a meeting of the official delegates of all the countries represented, the Constitution for UPADI was unanimously adopted. Of the 22 countries in the Western Hemisphere invited to the UPADI meetings and to the Congress, the following 17 sent delegates: Argentina, Brazil, Canada, Chile, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, United States, Uruguay and Venezuela. It was decided that when the national engineering societies of 15 nations have accepted the UPADI Constitution, the organization would be considered formed, and that thereafter an organization meeting would be held in Havana, Cuba, provided that country had accepted membership in the organization.

Throughout the discussions for the founding of UPADI, the United States delegation acted as observers and were available to advise and to express opinions regarding the probable attitude of the engineering profession in the United States with reference to each of the provisions of the proposed Constitution. The delegate from Canada and those from Venezuela acted also as observers. It appeared that the national engineering society of Venezuela is prohibited by present law from joining any outside organization such as UPADI; consequently, that country is the only one in South America not a member of USAI. Before the close of the Congress, it became apparent that the Venezuelan delegates would recommend that the engineers of

their country join UPADI if the legal prohibition can be removed.

The hope was expressed by all the assembled delegates that the United States engineers would find the Constitution of UPADI acceptable and that they would join that organization at an early date.

It is estimated that the potential membership of UPADI from its possible constituent organizations is 108,000 professional engineers, consisting of about 12,000 now in USAI, 90,000 represented by Engineers Joint Council, and 6000 in the other countries of the hemisphere, including Canada. The first Pan American Engineering Congress, officially authorized and sponsored by the Government of Brazil, was attended by 800 engineers, officials, and guests, representing nearly all the countries of the Western Hemisphere.

The program of the Congress was unusually comprehensive in scope and dealt with all the major branches of Engineering. The presiding officer was Engineer F. Saturnino de Brito Filho who did an excellent job in what were, at times, difficult situations. The official languages of the Congress were English, French, Portuguese, and Spanish. Translations were made at meetings as needed and requested by the delegates. It is interesting to note that of the 350 papers presented, more than a third were in English, somewhat less than a third in Portuguese, a smaller number in Spanish and only a few in French.

Each paper presented to the Congress was referred to one of nine Commissions dealing with the various branches of Engineering into which the Agenda were divided. These Commissions were as follows: (1) Transportation and Communications; (2) Construction; (3) Power; (4) Urban and Rural Engineering; (5) Sanitary Engineering; (6) Industrial Engineering; (7) Mining Engineering and Geology; (8) Teaching of Engineering; (9) Miscellaneous.

The procedure of holding technical meetings in Brazil, which is typical of all Latin America, is entirely different from our own and was new to most of our delegates. Each paper submitted to the Congress is referred to the appropriate Commission under which it belongs and a reporter is appointed to study it. The reporter presents his findings to the Commission, which then takes one of three actions: (a) the paper is recommended to be printed in full in the proceedings of the Congress; (b) the paper is recommended to be printed in abstract; or (c) the author is thanked for his efforts. The Committee's recommendations are submitted to a plenary session of the Congress, which, in most cases, automatically accepts the report of the Commission.

Other differences that might be noted between our technical meeting procedure and that in Brazil are the wide authority of the presiding officer to accept or reject a motion, even if properly seconded; and the almost unlimited debate that is allowed, calling for much patience on the part of those in attendance.

In closing this report, the writer wishes to express, on behalf of the United States delegation, its sincere appreciation of the unbounded courtesy and hospitality of its Brazilian hosts. Our delegates were enriched and stimulated by this opportunity of working closely and associating with the engineers of the other American republics.

Finally, the United States delegation unanimously recommends to Engineers Joint Council that it strongly urge its constituent organizations to study the proposed Constitution for UPADI and to take action to join that organization, whose purpose it is to unite with the other engineers of the Western Hemisphere in advancing the knowledge and the application of engineering techniques and to maintain that unity of professional understanding and action necessary to make effective the slogan of the First Pan American Engineering Congress, namely *"Engineering in the Service of Peace."*

Minutes of Executive Board Meeting

A meeting of the Executive Board of The American Society for Engineering Education was held on Thursday, October 27, 1949, in the Hotel Muehlebach, Kansas City, Missouri. Those present were: Thorndike Saville, *President*, H. H. Armsby, F. M. Dawson, B. J. Robertson, F. E. Terman, J. S. Thompson, A. B. Bronwell, D. Daum, and J. I. Mattill (visitor).

Report of the Secretary

The Secretary reported that the official vote on the constitutional amendments was as follows: approved: 3151, disapproved: 53, undecided: 18. In view of the fact that the amendments have previously received the unanimous approval of the E.C.A.C., the E.C.R.C., and the General Council, they have been officially ratified by the Society.

The Secretary reported that the Membership Committee, consisting of a state chairman for each of the 48 states, had been appointed and that the state committees are being made up.

Report of the Treasurer

The Treasurer presented his report for the first quarter of this fiscal year showing that receipts from dues were somewhat greater than those of the corresponding quarterly period last year, while the disbursements are approximately the same. This report indicates that the Society finances will probably be in line with the budget. The Executive Board voted to approve the Treasurer's report and recommended that future budgets of the Society include an item for the annual audit rather than placing this in the contingency account.

Report of the E.C.A.C.

In conformance with the recommendation of President Saville to assign each Committee to report to one of the Councils, the Executive Board voted to assign the Committee on International Relations to report to the E.C.A.C. Vice President Terman suggested that this Committee might explore the possibilities of obtaining scholarships and fellowships for foreign students and prepare an article on this subject for publication in an early issue of the JOURNAL.

The Executive Board requested that the E.C.A.C. continue its manpower studies of the supply and demand of engineering college graduates on a basis similar to studies conducted during the past few years.

Vice President Terman discussed plans for the E.C.A.C. conferences at the annual meeting and suggested that since the employment situation for engineering college graduates will probably be acute, the E.C.A.C. might devote one of its conferences at the annual meeting to this question.

Report of the E.C.R.C.

Vice President Dawson indicated that copies of the 1949 "Directory and Review of Current Research," complete with index, are now available.

He also reported that conference programs at the Annual Meeting would be prepared by the E.C.R.C. Committees on Relations with Military Research Agencies, Relations with Non-Military Research Agencies, and Relations with Industrial Research Agencies.

Vice President Dawson reported that the proposal for the publication of a brochure which would present the reasons for emphasizing fundamental research in engineering colleges, as well as the benefits to be derived from such research programs, had been widely accepted. Publication of the brochure will be started in the near future.

Report of Vice President in Charge of Divisions and Committees

Vice President Robertson reported that the chairmen of Divisions and Committees have been asked to start working on their programs for the annual meeting. As a first step, letters have been sent to the chairmen requesting that they inform the Secretary as to how many conferences, luncheons, and dinners they would like to have at the annual meeting. As soon as this information is received, a tentative schedule will be prepared.

The Executive Board voted that as soon as the names of the conference speakers have been received, the Secretary should send each speaker, free of charge, a copy of the booklet prepared by the Committee on Relations with Industry entitled "Speaking Can Be Easy."

Vice President Robertson moved and the Executive Board approved that the Report of the Interim Committee on Young Engineering Teachers be sent to all deans of engineering colleges, with a letter recommending that the deans urge their younger faculty members to participate in activities of the Society through the Section meetings and the annual meeting of the Society.

Vice President Robertson pointed out that a number of Divisions and Committees of the Society have their own publications. These provide an outlet for the more highly technical papers which would not be of interest to the A.S.E.E. membership as a whole and therefore would not be published in the JOURNAL. These publications have been placed on a self-sustaining basis by revenue received from company advertising or sale of subscriptions to Division or Committee members. The Board felt that these publications were serving a useful purpose and should be encouraged, but pointed out that the JOURNAL OF ENGINEERING EDUCATION should have first priority on the publication of papers presented at Society meetings.

Summer Schools

Vice President Robertson reported that it has been the practice of the Society in the past to sponsor only one summer school each year. The question was raised as to whether or not the Society could provide a greater service by sponsoring several summer schools each year, assuming that each summer school would be placed on a self-financing basis. This would make it possible for each curricular group to hold a summer school every three or four years, rather than every ten or twelve years as has been the practice in the past. The Executive Board expressed approval of the multiple summer school plan.

The suggestion was made that consideration be given to setting up one or two summer schools devoted to the teaching of physics to engineering students. This possibility will be explored by Vice President Robertson and the Secretary. Additional suggestions for summer schools are reported in the minutes of the General Council meeting.

Report of Vice President in Charge of Sections and Branches

Vice President Armsby reported that a meeting of the Committee on Sections and Branches was held on October 27 at which preliminary plans were made for preparation of the proposed Sections manual. The Committee hopes to have this manual completed by the June meeting.

He also presented a recommendation of the Committee of Young Engineering Teachers asking that the Sections consider the "development of the young engineer" as a possible theme for their Section meetings. This report will be submitted to the Section chairmen.

Point IV

Vice President Armsby reported on his liaison activities to cooperate with the government on matters relating to the Point Four program, which is a long-

range program designed to help the backward countries of the world in developing their own economies. This program is still in the planning stage. Vice President Armsby reported that Mr. Green, of the Department of Commerce, who is in charge of the technical planning of this program, hopes that the Society will be sufficiently interested in the possibilities of this plan to appoint a committee which would draw up an outline showing what the engineering colleges might do to assist in the program. The Board voted to defer appointment of a committee until the proposed committee on relations with government is established.

Dates of 1951 Meeting

The Secretary reported that the A.S.M.E. and A.S.T.M. are holding their annual meetings in 1951 during the week of June 18 to 22 and that the A.I.E.E. is holding its meeting during the week of June 25 to 29. Since these are the only two weeks available for the 1951 annual meeting of the A.S.E.E., it appears inevitable that a conflict will occur. Since the dates of our 1950 meeting conflict with the summer meeting of the A.S.M.E., it was felt advisable not to conflict with their summer meeting in 1951. For this reason, the dates of June 25 to 29, as suggested by Michigan State College, were officially approved.

The Secretary of the A.S.E.E. has attempted to arrange a conference with the secretaries of the A.S.M.E., A.I.E.E., and A.S.T.M. to discuss the possibilities of scheduling meetings in June so as to avoid conflict in the future. The three societies have all expressed willingness to meet and discuss this problem, and a conference on this subject will be arranged during the coming year.

Publication of Papers of Graduate Studies Division

The Division of Graduate Studies requested permission to publish in booklet form papers presented at its conference on cooperative graduate level education between industry, colleges, and the government. According to the proposal, the cost of typing would be handled by Brooklyn Polytechnic Institute, and the cost of reproducing would be borne by the Society. The Executive Board felt that it would be inadvisable for the Society to start a precedent of publishing in booklet form the papers of Divisions, Committees, and Sections, and therefore voted not to make a special appropriation for the project. However, it was pointed out that the Division of Graduate Studies would be eligible to receive financial assistance from the usual budgetary allotment to Divisions and Committees.

Student Chapters

President Saville reported that many of the founder engineering societies have expressed concern over the efforts of other organizations to institute competing student chapters in engineering colleges. A new "Inter-Societies Conference on Engineering Student Branches" has been formed to study this set of general principles problem. The Society has been invited to be represented on this Conference.

The following additional items considered in the Executive Board meeting are reported in the minutes of the General Council:

1. Reorganization of Committees
2. Proposal for A.S.E.E. fellowships
3. Study of financing of higher education
4. Inter-relationships between subgroups of A.S.E.E. and other organizations
5. Proposal of Visual Aids Subcommittee
6. Duties of Secretary and Treasurer

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

Minutes of General Council Meeting

A meeting of the General Council of The American Society for Engineering Education was held on Friday, October 28, 1949, in the Hotel Muehlebach, Kansas City, Missouri. Those present were:

Thorndike Saville, President
H. H. Armsby, Vice President
F. M. Dawson, Vice President (E.C.R.C.)
B. J. Robertson, Vice President
F. E. Terman, Vice President (E.C.A.C.)
J. S. Thompson, Treasurer
A. B. Bronwell, Secretary
D. I. Daum, Office Secretary
H. P. Adams, Technical Institute Division (representing K. L. Holderman)
H. W. Barlow, Aeronautical Division
H. J. Barre, Agricultural Engineering Division
L. R. Blakeslee, Architectural Engineering Division
H. R. Beatty, Evening Engineering Education Division
C. A. Brown, Michigan Section
M. E. Farris, Southwestern Section
C. J. Freund, Past President
R. P. Hoelscher, Engineering Drawing Division
H. K. Justice, Mathematics Division
R. D. Landon, Ohio Section
J. I. Mattill, Secretary, E.C.R.C. (visitor)
E. R. McKee, New England Section
M. B. Robinson, Cooperative Engineering Education Div.
F. L. Schwartz, Mechanical Engineering Division
J. E. Thornton, Social-Humanistic Division
J. K. Walkup, Industrial Engineering Division
K. F. Wendt, Mineral Engineering Division (representing G. J. Barker)
R. Z. Williams, Missouri Section

Reorganization of Society Committees

President Saville briefly discussed the reorganization of Society Committees whereby each Committee is assigned to report to one of the Councils and certain Committees which have discharged their responsibilities have been discontinued. He pointed out that the Society through its Councils, Divisions, and Committees had numerous relationships with the government which, up to the present time, have not been coordinated. He therefore recommended that a Committee on Relations with Government be established in the Society to serve as a coordinating committee. All activities of the Society relating to the government would then be cleared through this Committee before official action is taken. The Council voted to authorize such a Committee.

Acting upon the recommendation of the Executive Board, the General Council voted to discontinue the following Committees. In each case, the Past-Chairman of the Committee approved discontinuance of the Committee's activities: (1) Professional Development, (2) Teaching Manual, (3) Functions of the Vice Presidents, (4) Undergraduate Curricula.

As a further step in the reorganization of Society activities, President Saville reported that the Executive Board had recommended transferring the Committee on Selection and Guidance and the Committee on International Relations to the E.C.A.C. These recommendations were approved by the General Council.

• Vice President Dawson reported that, at the suggestion of the Executive Board,

a representative of the E.C.R.C. would be appointed to correlate the graduate activities of the E.C.R.C. with those of the Division of Graduate Studies of the Society.

The suggestion was made that the Technical Institute Division and the Junior Colleges Committee of the Society have a great deal of common interest in their programs and activities and that they might be interested in consolidating to form a single Division. Professor Adams, Chairman of the Technical Institute Division, explained that the Technical Institute Division has recently been reorganized and that it was confining its attention entirely to the furtherance of the technical institute type of education as defined by the E.C.P.D. For this reason, he felt that the merger would be inadvisable. The matter was referred to the Technical Institute Division and the Junior Colleges Committtee for their consideration.

A.S.E.E. Fellowships

A proposal submitted by H. O. Croft, Chairman of the Committee on International Relations, to establish a program of international fellowships under the sponsorship of the A.S.E.E. was discussed. According to this plan, each university would set aside one or two scholarships or fellowships for international students. Also, funds might be obtained through U.N.E.S.C.O. or the Committee on Educational Reconstruction of the U. S. National Commission. The plan would be publicized through U.N.E.S.C.O. and their assistance would be solicited in preparing lists of eligible graduate students. The lists would be sent to the deans of engineering colleges and the official appointments would be made by the various colleges. Acting upon the recommendation of the Executive Board, the General Council voted to approve the plan in principle, subject to further improvement in the terminology and mechanics of the plan by the Committee on International Relations, and subject to subsequent approval by the Executive Board at its meeting in the Spring of 1950.

Committee Reports

1. *Interim Committee for Young Engineering Teachers*

Professor Schwartz, Chairman of the Interim Committee, discussed the written report of his Committee. He stated that the Committee is planning to hold one or two conferences for young engineering teachers at the annual meeting in Seattle, and the formal organization of a permanent Society committee will take place at that time. According to the recommendations of the Interim Committee, members of the Committee must be under 35 years of age and hold a rank lower than that of associate professor. Professor Schwartz suggested that his Committee could work most effectively through the Sections and Branches, and urged that those groups offer programs of special interest to younger faculty members and encourage the participation of younger members in their programs. It was suggested that Professor Schwartz write to the deans of engineering colleges in the West Coast area urging that they send some of their younger faculty members to the annual meeting. It was also pointed out that summer school activities of the Society should be planned so as to attract younger faculty members.

2. *Visual Aids Subcommittee of Educational Methods Division*

The written report of the Subcommittee on Visual Aids was discussed. This provided for a plan of accreditation of visual aids by committees chosen in each of the various curricula areas. The cost of accreditation would be sustained by participating companies, and a list of accredited visual aids would be published in booklet form for distribution to the engineering colleges.

Acting upon the recommendation of the Executive Board, the General Council voted to endorse the plan, subject to the

following conditions: (a) Because of legal connotations, the words "accrediting" or "approving" or similar terms should be avoided, although the Committee's plan to list the various visual aids which are useful in engineering instruction was approved. (b) The Committee was authorized to solicit funds from industry, provided that no expenditures shall be made from the fund until a sufficient amount has been raised to assure accomplishment of the initial objectives for which the funds were solicited. (c) The funds are to be deposited in a special account set up under the control of the Secretary and Treasurer of the Society. The plan of disbursements is to be approved by the Executive Board.

3. *Steering Committee on Improvement of Teaching*

The written report of the Steering Committee on Improvement of Teaching was discussed. The Secretary reported that a highly successful meeting of the Steering Committee was held in Pittsburgh on October 15 and that the objectives of the Committee have been fairly well defined. B. J. Teare, Chairman of the Steering Committee, will send to President Saville a list of persons who have been recommended by the Steering Committee to be added to the Committee on Improvement of Teaching.

4. *Enrollment Statistics Committee*

Vice President Armsby reported that forms for the collection of the enrollment statistics have been mailed to the deans of the engineering colleges. The U. S. Office of Education will collect and tabulate the statistics from all schools offering B. S. degrees in engineering listed on the U. S. Office of Education list, but the Society will publish detailed figures only on E.C.P.D. accredited schools, and totals for all others included in the U. S. Office of Education list. It was voted that the enrollment statistics be printed annually in the *Yearbook* issue of the JOURNAL, and that reprints of the statistics are to be included as a part of the bound Proceedings for each year.

5. *Teaching Manual*

The Secretary announced that the teaching manual had been completed and was now in the hands of the printer. Professor Morris, author of the manual, will complete publication arrangements.

6. *Speakers Manual*

The Secretary announced that the speakers manual entitled "Speaking Can Be Easy," prepared by the Committee on Relations with Industry, has been endorsed by the E.C.P.D. and a plan of distribution will be worked out in cooperation with the E.C.P.D. and the Committee on Relations with Industry.

7. *Constitutional Amendments*

The Secretary announced that the constitutional amendments have been ratified by vote of the general membership, as reported in the minutes of the Executive Board meeting.

8. *Division Status for Relations with Industry*

President Saville announced that the Committee on Relations with Industry had now obtained full Division status, in view of the recent ratification of the constitutional amendments and in accordance with the action of the General Council at its meeting on June 20, 1949.

9. *Census Committee*

President Saville called the Council's attention to the written report of Vice President Armsby as Chairman of the temporary Census Committee of the Society to collaborate with the Bureau of the Census in the recommendation of additional classifications of engineers to be used in census tabulations. Vice President Armsby stated that the recommendations of the Committee have been approved and will be put into effect.

Yearbook

The Secretary reported that the new format for the *Yearbook,* adopted by the Executive Board, would result in a savings of $700 annually on future issues. During the coming year, this savings will be offset by the increased cost of setting new type, since previous issues of the *Yearbook* have been printed from standing type.

Financing of Higher Education

President Saville reported that a substantial grant has been received by the Association of American Universities from the Rockefeller Foundation and the Carnegie Corporation to conduct an investigation of financing higher education. President Saville has contacted Dr. Millett, Director of the project, to investigate the possibility of A.S.E.E. participation in this project. Dr. Millett expressed interest in the possibility of having the A.S.E.E. conduct a survey of the costs of engineering education. Since plans for this project may crystallize in the near future, the General Council voted to authorize the Executive Board to collaborate with the Commission of the Association of American Universities and enter into a contract to carry on a study of the costs of engineering education if this action is deemed desirable by the Executive Board. In the event that this project is undertaken, it will be assigned to the E.C.A.C.

Revision in Nominating Procedure

The following procedure for the nomination of officers of the Society was approved by the General Council: (a) nomination ballots will be published in the December and January issues of the JOURNAL, with prominently displayed notice to members of the Society; (b) two informal ballots by letter will be taken by the Nominating Committee in March or April; (c) the Nominating Committee will meet on Monday afternoon at the Annual Meeting for the purpose of making final nominations; (d) the report of the Nominating Committee will be presented and election of officers will be held at the Wednesday morning General Session.

Annual Meeting

President Saville announced the plan of events for the Annual Meeting, which includes general sessions on Wednesday morning and Wednesday afternoon only, with a report on Society activities, the election of officers, and two addresses taking place at the general session on Wednesday morning. The E.C.R.C. and E.C.A.C. will hold general conferences on Tuesday and Thursday mornings, respectively, concurrently with non-conflicting conferences of Divisions and Committees.

The Secretary reported that at the Rensselaer annual meeting, abstracts of papers were mimeographed and made available at the door of each conference session prior to the meeting. This involved a considerable amount of work and a moderate expense. The question was raised as to whether or not the benefits derived warranted a continuance of this procedure. The Council agreed that this matter should be left to the discretion of the Divisions and Committees. If they wish to have copies of papers or abstracts available at the annual meeting, they will either request the authors to prepare these or make their own arrangements for the reproduction.

Additional suggestions were made regarding details in the conduct of annual meetings. These will be referred to the host institution.

Summer Schools

The Secretary reported that tentative proposals have been received for a summer school in mechanics at Iowa State College and a summer school in the social-humanistic field. It has also been suggested that summer schools be held on the teaching of engineering physics and English. The General Council voted to

authorize the Executive Board to approve such summer schools as it deems advisable.

The Council also voted that the Vice President in charge of Divisions and Committees undertake to organize a group to study the entire Summer School pro-

Duties of the Secretary and Treasurer

Since the duties of the Secretary and Treasurer are not explicitly stated in the Constitution and By-Laws of the Society, the General Council, acting upon the recommendation of the Executive Board, authorized the continuance of the following procedures which have been in effect in the operation of the Society: (a) The Executive Board has final authority over all budgets, authorization of disbursements, investments, and other financial matters of the Society. (b) The Treasurer examines all monthly bank statements and the final audit, and is official advisor to the Executive Board in all financial matters. (c) The Secretary receives, disburses, and accounts for all funds of the Society; is responsible for all properties, including securities; submits quarterly financial statements to the Executive Board; and is responsible for having the books audited annually. (d) All checks and vouchers shall be co-signed by the Secretary and Treasurer of the Society. In the event of the absence or incapacity of the Secretary, the Assistant Secretary is authorized to co-sign checks and vouchers; in the event of the absence or incapacity of the Treasurer, the President is authorized to co-sign checks and vouchers. The Treasurer, Secretary, and those employees who handle funds shall be bonded at the expense of the Society.

The General Council requested that these procedures be referred to the Committee on Constitution and By-Laws for possible inclusion in future constitutional revisions.

It was also voted that Mrs. Dorothy Daum be appointed Assistant Secretary of the Society, such appointment to be on an annual basis.

Inter-relationships between subgroups of the A.S.E.E. and other organizations

In view of the increasing inter-relationships between subgroups of the A.S.E.E. and other organizations, the General Council, acting upon the recommendation of the Executive Board, voted that any cooperative undertaking between individuals or subgroups of the Society and other organizations should first receive the approval of the Executive Board. The Vice Presidents were requested to call this ruling to the attention of the various Society groups. This matter will be referred to the Committee on Constitution and By-Laws.

Unification of the Profession

As the A.S.E.E. representative to the committee of the Engineers' Joint Council working on unity in the engineering profession, President Saville reported that two tentative plans have been proposed: (1) To modify the constitution of the N.S.P.E. whereby registration will not be required for membership, and authorize this organization to represent the engineering profession in matters relating to government or the engineering profession as a whole. (2) To adopt a federated society plan, perhaps by expanding the E.J.C., to serve as an organization to unify the engineering profession.

President Saville reported that a subcommittee has been appointed to study this problem and make recommendations. This Committee will meet in January, and the Executive Board and General Council will be kept informed of developments.

Interpretation of Dues Rates

Acting upon the recommendation of the Executive Board, the General Council voted that members of the Society will qualify under the \$5.50 and \$6.00 dues status as listed in the Constitution and By-Laws only when their full-time services are related to the activities of educational institutions.

Life Memberships

The General Council voted that life membership should be granted to the following applicants, and the Secretary was instructed to notify these applicants of this action: Frederic Bass, J. L. Beaver, W. R. Bryans, A. M. Buck, Edwin F. Church, Jr., L. E. Conrad, T. T. Eyre, O. J. Ferguson, A. R. Keller, H. N. Lendall, F. W. Owens, John C. Parker, Harold Pender, John C. Penn, B. F. Raber, P. K. Slaymaker.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	April 14 & 15, 1950	D. M. Griffith, Bucknell University
Illinois-Indiana	Purdue University	May 13, 1950	D. S. Clark, Purdue University
Middle Atlantic	Lehigh University	May 13, 1950	C. H. Willis, Princeton University
National Capital Area	Washington, D. C.	Oct. 4, 1949	H. H. Armsby, U. S. Office of Education
New England	Yale University	Oct. 8, 1949	C. E. Tucker, Massachusetts Institute of Technology
North Midwest	University of Iowa	Nov. 3, 4, and 5, 1949	C. J. Posey, University of Iowa
Pacific Northwest	University of Idaho	1951	A. S. Janssen, University of Idaho
Pacific Southwest	Stanford University	Dec. 28 & 29, 1949	R. J. Smith, San Jose State College
Southeastern	Virginia Polytechnic Institute	April 20, 21, & 22, 1950	H. G. Haynes, The Citadel
Southwestern	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University
Upper New York	University of Buffalo	Fall, 1950	F. H. Thomas, University of Buffalo

Candid Comments

HOW TO WRITE A DIFFICULT LETTER

Dean ————
The University of ————
College of Engineering

Dear Dean ————:

Since I received your letter of May 8, I have been considering carefully your request respecting the recommendation of Mr. Blank. This letter is, therefore, not the ordinary type of recommendation but a sincere, definite, statement of facts regarding Mr. Blank who will receive his Master's Degree in Sanitary Engineering in June of this year.

I have known Mr. Blank since 1937 at which time he entered as a beginning student in engineering. I wish to be clear in that I am not recommending him as a top student scholastically but in all of the years of my teaching experience I have not found a young man who has done better under adverse conditions. He was greatly handicapped by having to earn a greater part of his expenses while in college and although he managed to get through it was not with a very good grade-point average. About a year before he was to be graduated, he was called to service as a private in the National Guard. He served all during the war and was discharged as a first lieutenant having been awarded the Silver Star, Purple Heart, and four or five unit citations. Since he returned to the University, the second semester 1945–46, his scholastic average has improved considerably and he has shown that he is capable of doing good work.

Now the real reason I am recommending him to you so strongly is that he took hold of a tough situation here in teaching surveying and also in assisting with other courses, and he did a reasonably good job. He is tall, well built, and is a good, though quiet, speaker. A year and a half ago he represented the University at a state honor meeting for engineering students and gave by far the best talk to the group. During the last two years he has been assisting in various capacities in teaching and in student activities. My only complaint about him is that he is somewhat retiring and does not give the appearance at first of being very keen and alert. However, this soon wears off because he is always on the job. If you are looking for a man in civil engineering who could teach sanitary engineering and practically any other subject in the curriculum of a more elementary type, I do not believe that you could do better than to suggest to the Department of Civil Engineering that they look seriously into the qualifications of Mr. Blank.

One of the things in his favor is that his wife is a very nice woman, they have three children, and they both can hold their own in any social gathering. If you are looking for a brilliant research investigator, then I would not recommend Mr. Blank; but if you are looking for someone who is a good teacher and who would have the respect of his students at all times, then he is as good as you will get. His broad experience on construction projects would be of help in any capacity. Although he is getting his Master's Degree in Sanitary Engineering, he has been broadly trained in all branches of the work in Civil Engineering.

Very truly yours,

Dean

New Members

AIRD, C. CLIFTON, Assistant Professor of Geology, Michigan College of Mining and Technology, Houghton, Mich. E. L. Wood, G. W. Swenson.

ALBRITTON, JACK H., Technical Instructor, Vocational Dept., University of Houston, Houston, Texas. W. B. Lowe, W. T. Kittinger.

ARTLEY, JOHN L., Assistant Professor of Electrical Engineering, University of Arkansas, Fayetteville, Ark. W. B. Stelzner, G. F. Branigan.

BARBER, CARL S., Instructor in Technical Drawing, Illinois Institute of Technology, Chicago, Ill. H. C. Spencer, I. L. Hill.

BEATTY, JOHN M., Associate Professor of Structural Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. E. J. Kilcawley, J. S. Kinney.

BELANGER, ROBERT N., Instructor in Electrical Engineering, Michigan College of M. and T., Houghton, Mich. G. W. Swenson, V. O. York.

BIGGS, JOHN M., Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. M. J. Holley, Jr., H. J. Shea.

BIRD, GEORGE T., Assistant Professor of Electrical Engineering, University of Houston, Houston, Tex. W. T. Kittinger, W. B. Lowe.

BLAKELY, MATTHEW L., Assistant Professor of Civil Engineering, University of Connecticut, Storrs, Conn. K. C. Tippy, F. L. Castleman, Jr.

BODGER, W. KENNETH, Associate Professor of Mechanical Engineering, Case Institute of Technology, Cleveland, Ohio. W. E. Nudd, O. M. Stone.

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BOLTON, JOHN H., Bulletin Editor, Engineering Experiment Station, Iowa State College, Ames, Iowa. F. Kerekes, G. R. Town.

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TAYLOR, GEORGE A., Assistant Professor of Engineering and Management, Thayer School of Engineering, Dartmouth College, Hanover, N. H. W. P. Kimball, M. G. Morgan.

THOMAS, WILLIAM A., Associate Professor of Electrical Engineering, Case Institute of Technology, Cleveland, Ohio. O. M. Stone, C. W. Coppersmith.

THOMPSON, A. RALPH, Assistant Professor of Chemical Engineering, University of Pennsylvania, Philadelphia, Pa. R. E. Voner, M. C. Molstad.

THUERING, GEORGE L., Instructor in Industrial Engineering, Pennsylvania State College, State College, Pa. C. Bullinger, M. M. Babcock.

TIFFORD, ARTHUR N., Associate Professor of Aeronautical Engineering, Ohio State University, Columbus, Ohio. G. L. Von Eschen, F. M. Mallett.

TYLEE, ANDREW F. E., Head of Engineering Dept., Seddon Memorial Technical College, New Lynn, Auckland, S.W.4, New Zealand.

VARNER, WALTER W., Instructor in Applied Mathematics, University of Colorado, Boulder, Colo. G. Dobbins, W. K. Nelson.

VOGT, CHRIS. A., Associate Professor of Mechanical Engineering, University of Houston, Houston, Tex. W. B. Lowe, W. T. Kittinger.

WANG, CHI-TEH, Associate Professor of Aeronautical Engineering, New York University, New York, N. Y. F. K. Teichmann, G. H. Strom.

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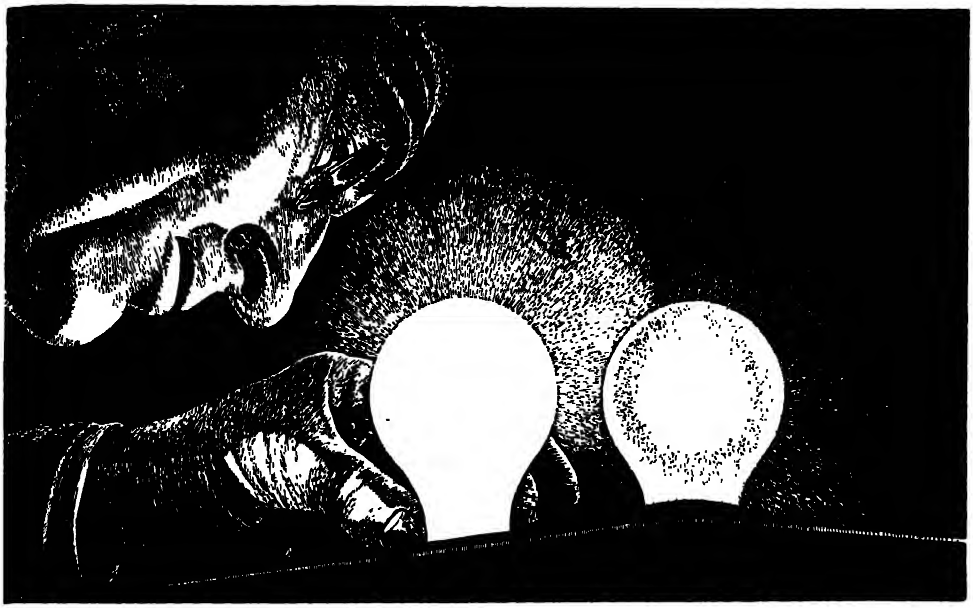
YOUNG, LYLE E., Instructor in Drawing, University of Minnesota, Minneapolis, Minn. L. G. Palmer, H. D. Myers.

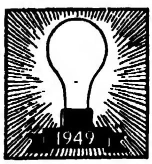
Total new members this year 351



The lamp that's bright all over—*an inside story...*

You could look directly through the clear glass of Edison's first lamp and see the hot filament. While this may have been interesting, the glare made it unpleasant. Many attempts were made to diffuse the light and cut the glare by coating the bulb, without loss of too much light.

A General Electric lamp researcher named Marvin Pipkin was the first to offer a practical inside frosting for lamps, with little light loss. His method, perfected in 1925, was a milestone in lamp research. The G-E inside frosted incandescent lamp is still today the one most commonly used.



But during years of work on many varied lighting projects, Pipkin kept up the search for a still better coating. He has found it—a new silica finish that diffuses the light almost perfectly and gives softer, more beautiful illumination. It is used in the G-E Deluxe-White Lamp now on the market.

This new success of Marvin Pipkin has come only after thousands of experiments and years of investigation. It illustrates again how General Electric emphasizes research and creative thinking, encourages fertile minds to follow their own imaginative bent, and so stays in the forefront of scientific and engineering development.

You can put your confidence in—

GENERAL ELECTRIC